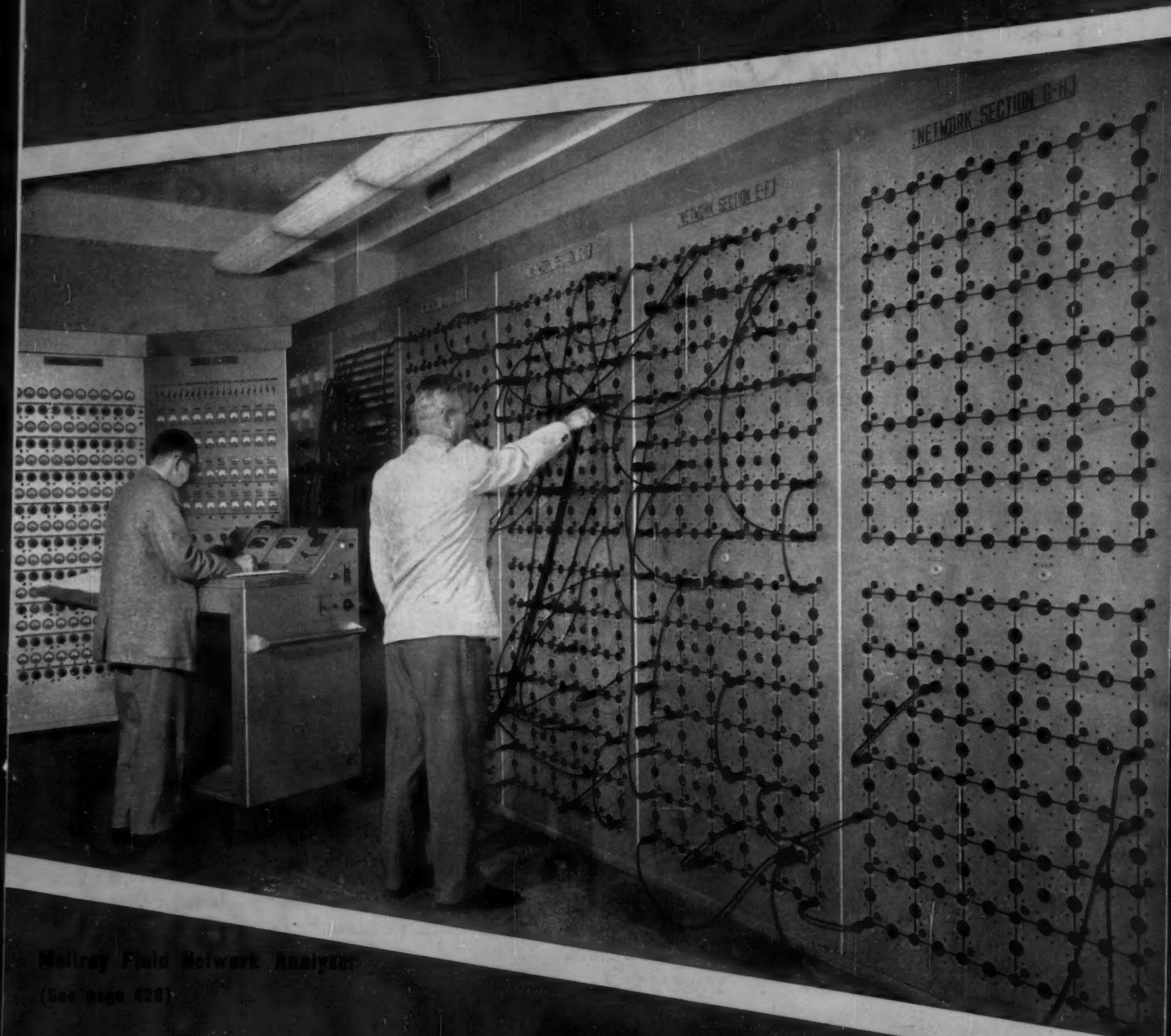
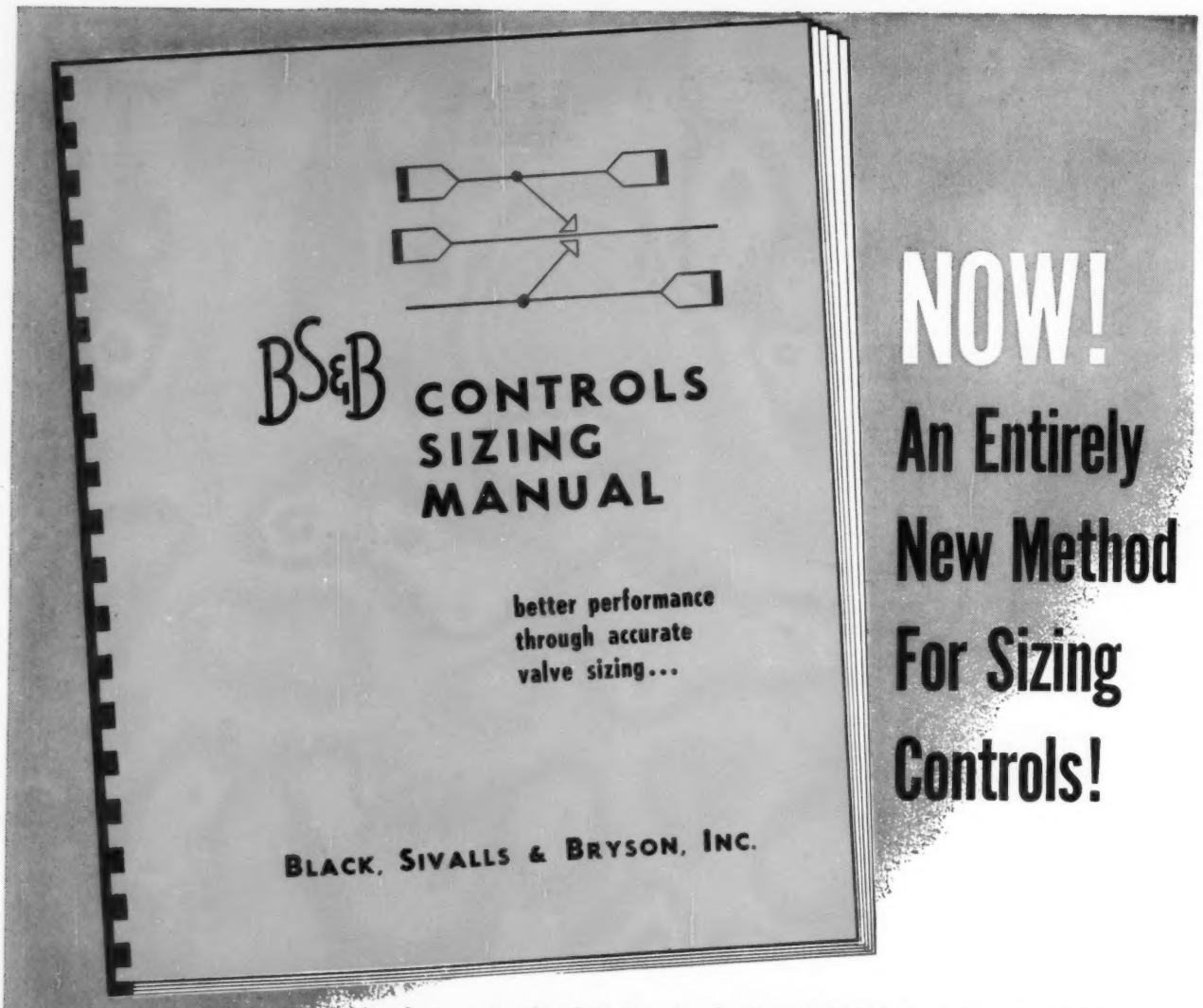
INSTRUMENTS and AUTOMATION



Mallroy Fluid Network Analyzer
(See page 428)

Including—Journal of the SCMA

Volume 28, Number 3 March, 1955



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BS&B's New, Exclusive Method Takes Both The GUESS And The WORK Out Of Controls Sizing For Liquid, Steam And Gas Applications!

Today's modern and complex processing systems require accurate control valve sizing. No one has recognized this fact more than BS&B.

Therefore, as a service to industry, BS&B set out to develop a new, simple, more accurate method of sizing controls. Here it is in the new BS&B Controls Sizing Manual.

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These "tools" are based upon thousands of hydraulic flow tests performed on all sizes and types of BS&B Controls in the industry's largest and most modern flow testing laboratory. Results are proven by correlation with *actual* gas and steam flow tests.

If you'd like a copy of this new manual, write to . . .

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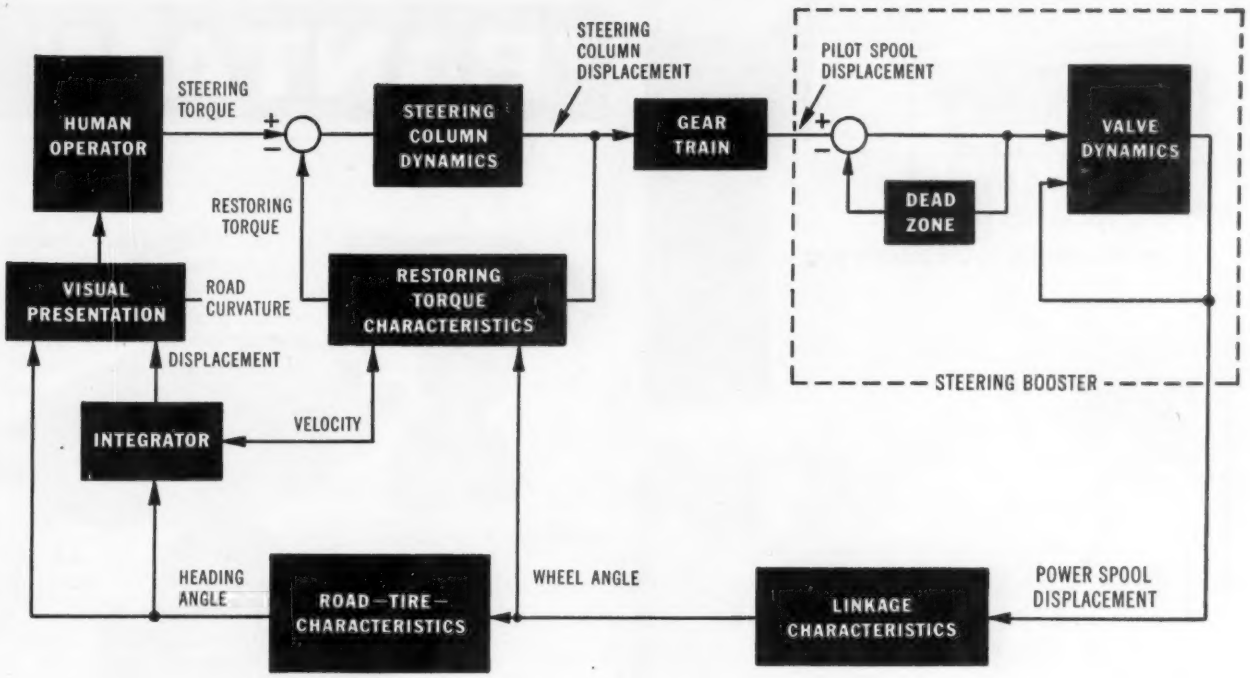

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HERE'S A GOOD STEER — for the automotive industry, or ANY industry! Set up any problem, inject your own variables—*and throw away empirical "guesswork"!*

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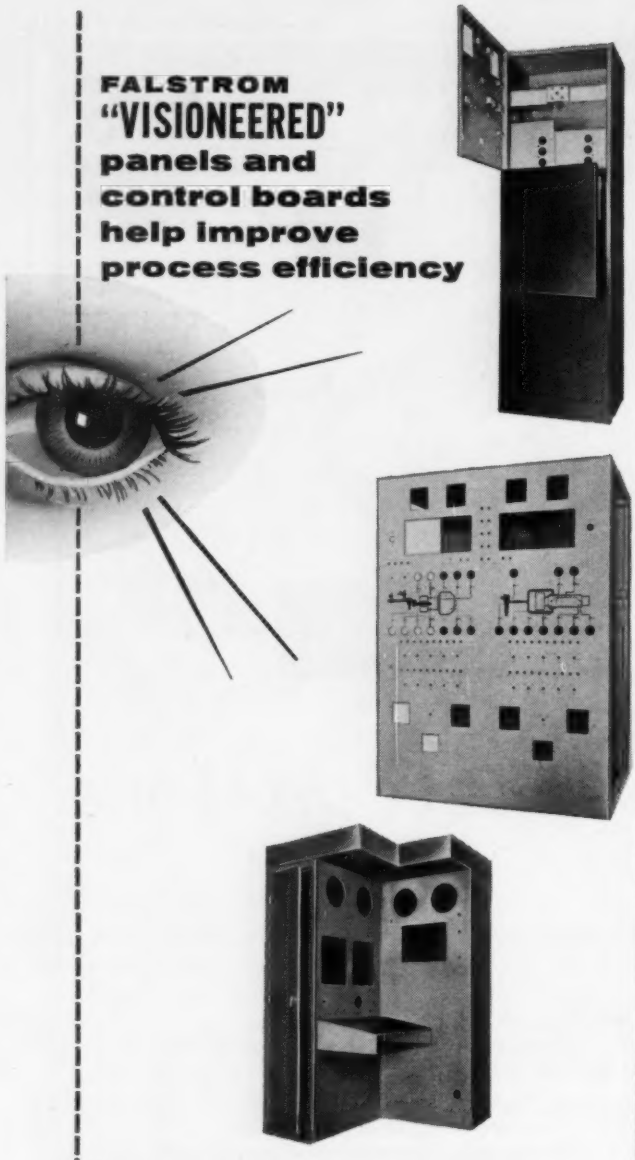
GEDA—T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

GOODYEAR AIRCRAFT

For more information circle **2** on inquiry card.

FALSTROM
"VISIONEERED" panels and control boards help improve process efficiency



Falstrom "visioneered" steel instrument and control boards, graphic panels, consoles, cubicles and cabinets are made exactly to your designs and specifications so as to achieve better functional integration of your instruments, for easier supervision with less fatigue. Falstrom fabrications are made to close tolerances and because of Falstrom's large facilities and modern equipment, no need to sacrifice or compromise on your original specifications and intentions.

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Write for Falstrom catalog of standard panels and control boards 143A or send prints and requirements for prompt estimate.

FALSTROM

FALSTROM COMPANY
92 Falstrom Court, Passaic, N. J.

For more information circle **3** on inquiry card.

"BANTAM"

NEW WEIR TYPE VALVES

The ½" "Bantam" Valve shown at left has a plastic body, teflon diaphragm, cast iron bonnet, aluminum superstructure, air-to-close, spring-to-open.

The 3" Valve shown is of cast iron, rubber-lined, with a Neoprene diaphragm, cast iron bonnet, steel diaphragm operator, air-to-close, spring-to-open.

Reverse-acting operators are also available.

The operator as shown on the 3" Valve can also be supplied with dual control air connections, eliminating the spring entirely. With the use of a 4-way pilot valve, this operator may then be used to open or close the valve.

Diaphragm operators available with 15-100 sq. in. effective area. In all of our designs we try to minimize weight and space requirements.

For prices, in various materials and porting arrangements, inquire of our local representative in your area, or directly to our home office.

George W. DAHL Company
BRISTOL, RHODE ISLAND

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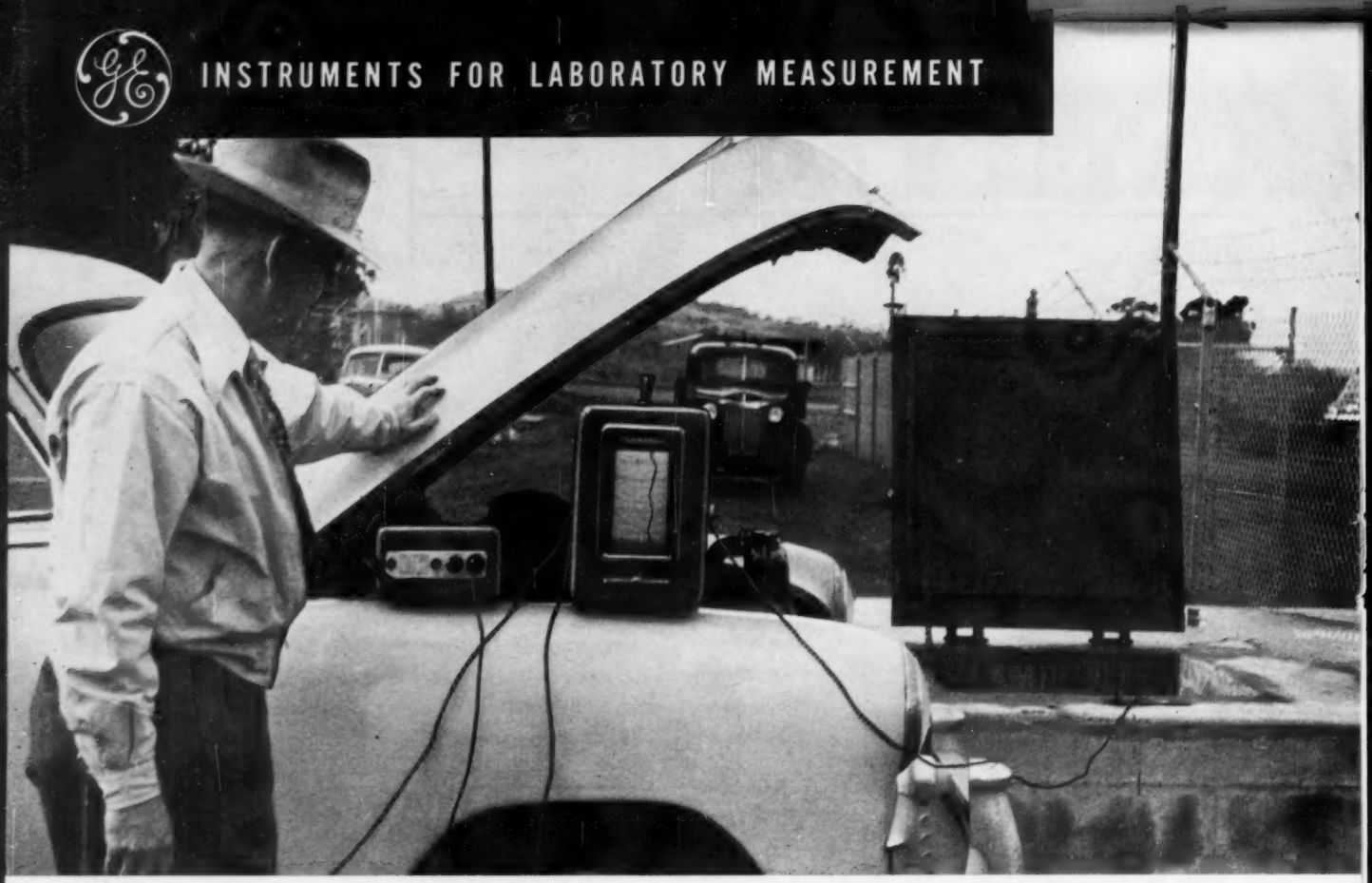
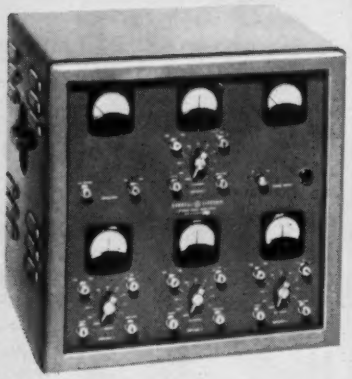
INSTRUMENTS FOR LABORATORY MEASUREMENT



LABORATORY FIELD TESTS are successfully conducted by the East Bay Municipal Utility District, Oakland, California, by using G.E.'s photoelectric recorder to locate pipe-line corrosion. Fred Terry, District Corrosion engineer, found that this recorder provided the most satisfactory method of determining where corrosion danger exists. The recorder was used to make electrolysis surveys of a 94-mile stretch of pipe. A car battery and 60-cycle vibrator furnished the power. The recorder does not need constant balancing.

News About Other General Electric Instruments for Precision Measurement in the Laboratory

STRAIN GAGE AMPLIFIER



STABILIZED for line-voltage, or tube-characteristic variations, the strain gage amplifier operates on d.c. or 0 to 1500 cps a.c. Two-channel, $1900.00; four-channel, $3200.00*.

SELF BALANCING POTENTIOMETER

HIGHLY STABLE MEASURABLE CURRENTS are furnished from small d-c voltages. Input: 100 uv to 1 v, d.c. Output: 5 ma d.c. for all output circuits up to 1500 ohm. $258.19*.

Manufacturer's suggested retail price.

For more information circle **5** on inquiry card.

FROM LABORATORY ANALYSIS TO FIELD TESTING . . .

G.E.'s Portable Photoelectric Recorder Assures Precise, Convenient Measurement

Designed for recording rapidly changing phenomena, General Electric's photoelectric recorder features unlimited versatility combined with the convenience of portability. With sensitivity and response characteristics of the most sensitive indicating instrument, the portable photoelectric recorder can provide direct ink records of the transient phenomena being investigated.

HIGH-SPEED RESPONSE, as high as 1/5 second for full-scale deflection, is another outstanding feature of G.E.'s recorder. Chart speeds range from ½ inch per hour to 72 inches per minute, and sensitivities are as great as 1.0 microamperes full-scale. Single-, double-, and triple-speed chart carriages are available.

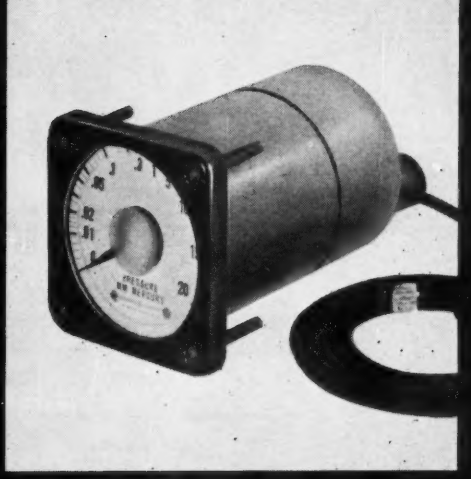
HIGHLY VERSATILE, G.E.'s photoelectric recorder is ideal for any permanent or temporary test where only a small amount of energy is available to deflect the recorder pen. The amount of energy required to operate the portable recorder can be in the order of one millionth of the energy required to operate a direct-acting recorder.

DESIGNED FOR PORTABLE USE, the photoelectric recorder is supplied with a convenient carrying strap and weighs but 35 pounds. The recorder can be used to record electrical quantities, such as volts, amperes, and frequency, and non-electrical quantities, such as speed, sound, pressure, strain, light, and vibration. Price is $698.88*.

INFRARED METER

SIMPLE AND CONVENIENT measurement of radiant energy intensity of 0 to 10 watts per sq. in. is provided. Response range is 0.3 to 3.5 microns. Price, $48.75* or $67.47*.

MOLECULAR VACUUM GAGE



NO PRIMARY ELEMENT TO BURN OUT, this new gage is provided with a dry-air scale of 0 to 20 mm; or for other gases, 0 to 100 uniform scale divisions. Price, $195.00*.

SECTION E605-75
GENERAL ELECTRIC COMPANY
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- ☐ Strain Gage Amplifier (GEC-1248)
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GENERAL ELECTRIC

For more information circle 5 on inquiry card.

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It is the same reason that 5-WAY Binding Posts are the first choice among *all* makers of electrical and electronic equipment. These binding posts help the manufacturer design and deliver a better product — both in performance and appearance. They give the maker and the user *more* for his money.

Send coupon below for Bulletin BP652 giving full details on 5-WAY Binding Posts.

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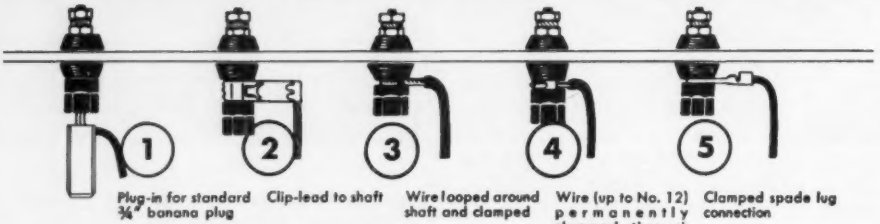
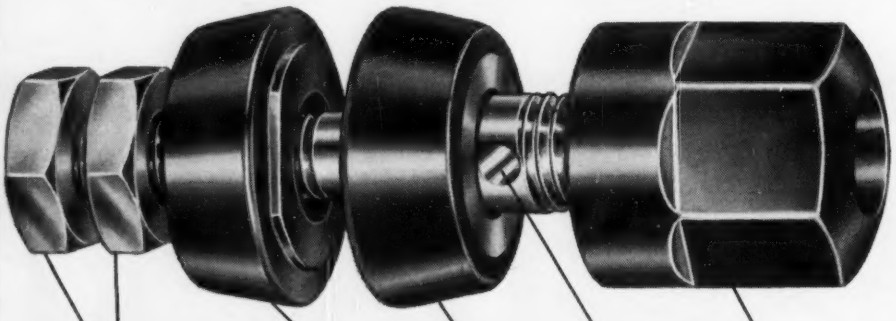


1. Plug-in for standard ¾" banana plug
2. Clip-lead to shaft
3. Wire looped around shaft and clamped
4. Wire (up to No. 12) permanently clamped through center hole
5. Clamped spade lug connection



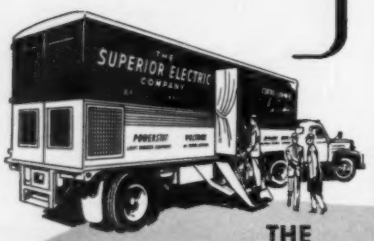
Twin hexagonal 10x32 brass nuts

Sliding panel-mounted insulator. Flatted insert for locking to panel.

Panel insulator over brass cone frozen to shaft. Flatted insert for locking to panel.

Hole in center shaft for wire up to size No. 12.

Hex thumb nut with insert captive with stud.



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hermetically sealed or dust-protective enclosures

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Current ratings up to 25 amp, AC or DC

When you want the utmost in relay dependability, investigate the Amrecon line. Amrecon relays are designed, produced, and tested in the new, air-conditioned Ohmite plant.

These ruggedly built relays have the ability to handle power loads usually requiring larger, heavier units. They are built to meet rigorous aircraft relay standards, and are particularly adapted to mobile equipment where severe shock and vibration are encountered.

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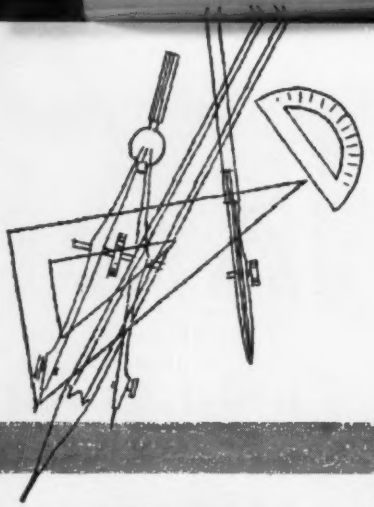
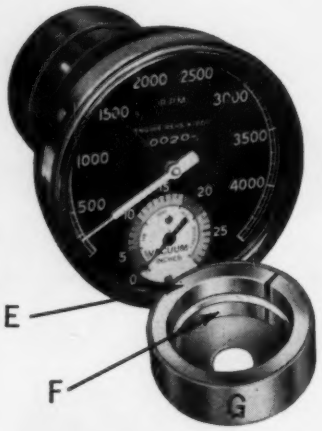


TELEPHONE PAY STATION

70% Cost reduction . . The manufacturers wanted to cut production costs on this pay station. They wanted more positive mechanical action built into the unit . . to minimize service calls. So their engineers, cooperating with Indiana Permanent Magnet engineers, designed a new magnet assembly using specially designed Indiana Permanent Magnet (A), replacing a conventional type steel magnet. Assembly functioned as a part of coin return assembly (B). Results were (1) flux increase 27% . . from 2750 Maxwells with steel magnet to 3500 with Indiana Permanent Magnet using Alnico III, (2) magnet cost reduced 70%, (3) weight saving, (4) simpler design, (5) fewer service calls required.

TACHOMETER



Improved stability . . This company wanted a permanent magnet assembly that would produce sufficient torque and give added stability to this tachometer. By varying the analysis and heat treatment of the magnet material, Indiana Permanent Magnet engineers developed special Cunife permanent ring-magnets (E) and (F) which, as component parts of permanent magnet assembly (G), provided the necessary torque and improved stability. Results were: (1) the desired torque and improved stability; and (2) the redesigned magnet lent itself better to the limited space resulting from the new design.

ELECTRONIC DATA PROCESSING MACHINE

Immediate signal pickup . . This computer manufacturer required a permanent magnet to build up a magnetic surface of the *drum* used in Magnetic Reader and Recorder . . a unit of its Electronic Data Processing Machine. Indiana Cunife Permanent Magnets were selected. Results: Strong, dependable signals because of the high coercivity and permanence of Indiana Permanent Magnets. Another permanent magnet (Indiana Alnico) was used for the housing (H) in the magnetic *tape* Reader and Recorder unit of the processing machine. Results: Immediate signal pickup . . sensitivity high because of magnet's high efficiency.

Here are six thumbnail case histories of permanent magnet applications. You'll notice they all have one thing in common. *Special engineering and design service* by Indiana Permanent Magnet engineers . . design service that reflects original thinking, creative thinking, imaginative thinking . . was an important part of each story!

This specialized service is available to you without obligation. Indiana Permanent Magnet engineers, with more than 45 years experience in designing permanent magnets for some 40,000 applications, will welcome the opportunity to assist you in the development of *your* permanent magnet designs.

Indiana maintains the *world's largest engineering staff devoted solely to the design and application of permanent magnets . .* and the world's largest and most complete permanent magnet research and production facilities.

For additional details and a copy of Engineering Design Manual 4-D-3, write The Indiana Steel Products Co., Valparaiso, Ind.

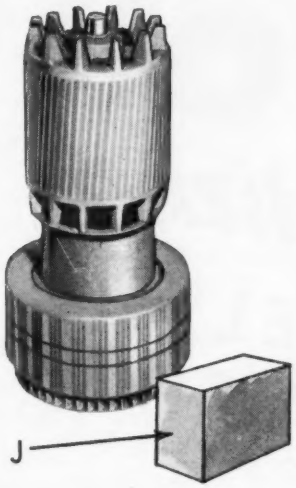
World's Largest Manufacturer of Permanent Magnets

For more information circle 8 on inquiry card.

Permanent Magnet Design

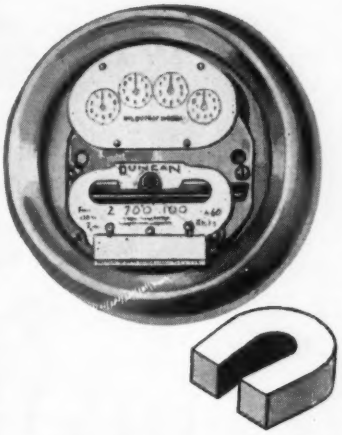
helped these original equipment manufacturers
reduce costs . . improve performance . . simplify design

GENERATOR



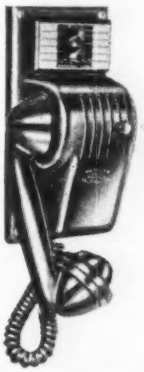
Permits uninterrupted service . . This permanent magnet generator uses 28 Hyflux Alnico V, bar-shaped Indiana Permanent Magnets. Minimum maintenance and long service are two "musts" in generators . . and Indiana Permanent Magnets help insure these qualities. These magnets (J) eliminate necessity for slip rings and commutators, which in turn eliminate sparking and resulting radio or TV interference. And there's no heat from the field coils . . nor is excitation power needed.

WATT-HOUR METER



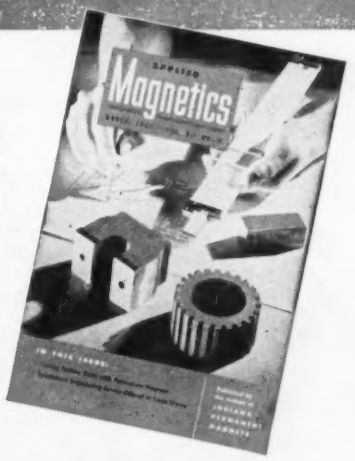
Insures field stability . . This watt-hour meter is typical of hundreds of different types of instruments and meters using permanent magnets. A single phase, 15-amp, 240-volt unit, it uses an Alnico I Indiana Permanent Magnet weighing only 0.2 lb. Uniformity and stability of field, so necessary for maintaining the initial accuracy of this meter over a long period of years, is provided by magnets of the type shown above. Similar magnets are widely used in mass spectrometers, vibration pickups, galvanometers, medical instruments, speedometers, fluxmeters, etc.

SOUND-POWERED TELEPHONE



Compactness . . was an important consideration in the design of this electric self-powered telephone. It is powered not by batteries nor other outside power sources . . but rather by sound waves which initiate a series of electrically activated impulses. Working with Indiana Permanent Magnet engineers, the manufacturer, by selecting Indiana Sintered Alnico II, was able to use extremely small magnets while maintaining high performance requirements. "Indiana Sintered Alnico II," reported this company's sales manager, "made possible small magnets of high coercive force, *the greatest single factor in size reduction of transducers* compared to that possible with other alloys."

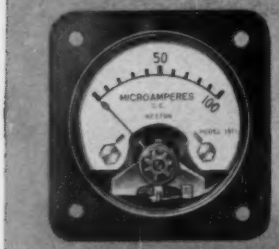
Free Subscription: Write for your subscription to "Applied Magnetics" . . a bi-monthly publication carrying helpful and practical information about permanent magnets and their application to industrial and consumer products. Please write on your company letterhead.



INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY, VALPARAISO, INDIANA

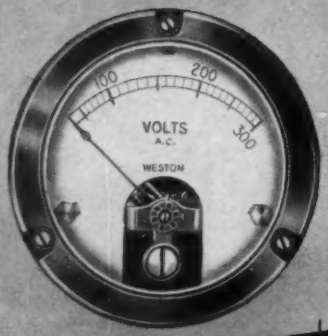
For more information circle **8** on inquiry card.



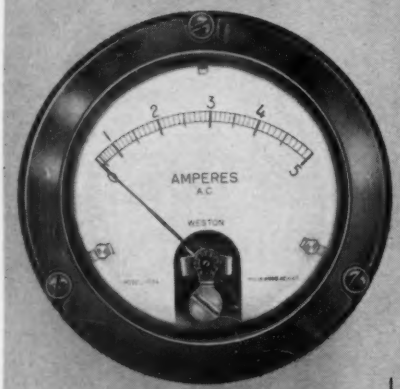
1½" APPROVED

APPROVED
-in all sizes

WESTON
Ruggedized
PANEL INSTRUMENTS
(A-C • D-C • RF • THERMO)



2½" APPROVED



3½" APPROVED

APPROVED

4½"

Available in *all* standard panel instrument sizes, equipment designers now can specify ruggedized meters in the exact size required for any built-in equipment need. For complete information on WESTON Ruggedized Panel Instruments, including types and ranges available, communicate with the Weston representative in your vicinity, or write direct to... WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.

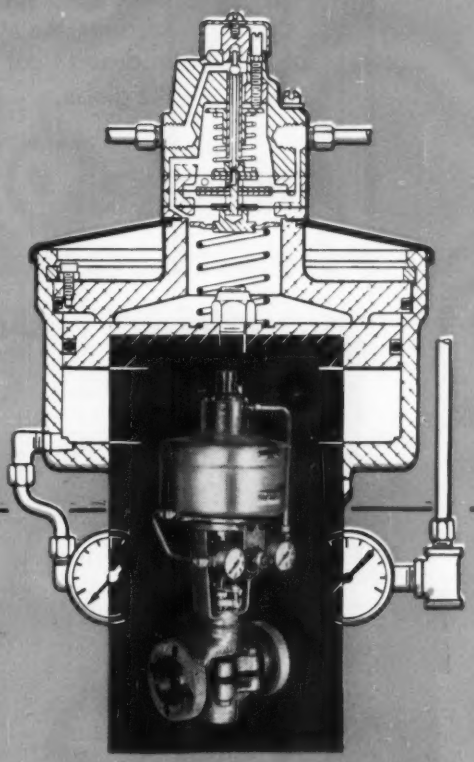
WESTON INSTRUMENTS

For more information circle 9 on inquiry card.

OUTMODES ALL OTHERS

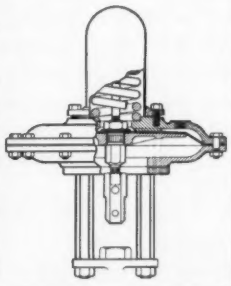
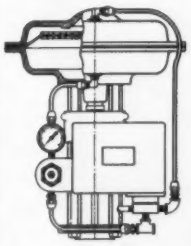
for Throttling Control Service

. . . CONOMOTOR SERIES LB VALVES



Conoflow is unbiased in evaluating the relative merits of the Cylinder Conomotor over spring-and-diaphragm and springless diaphragm motors. Conoflow makes all three. But look at the chart below . . . There's not merely an "edge", but a *wide margin* of superiority in the Cylinder Conomotor . . . in weight . . . in compact size . . . in speed of operation . . . stem travel . . . and thrust. No other operator surpasses it for positioning accuracy and stability of operation. Diaphragm breakage is eliminated and maintenance is greatly reduced. It's easy to convince yourself. Just try one or several . . . and you'll standardize right down the line on Conomotor Series LB Control Valves.

(COMPLETE DETAILS IN CATALOG LB-1)

Check these Points of Superiority in the CONOFLOW PNEUMATIC CYLINDER OPERATOR			
MODEL	B-10-TM Spring & Diaphragm Motor	B-12-T Springless Diaphragm Motor	**B-53 Cylinder Conomotor**
PISTON OR DIAPHRAGM AREA	←	50 square inches	→
THRUST	750 lbs.	1250 lbs.	**4500 lbs.**
STEM SPEED	12 seconds	10 seconds	**4 seconds**
TRAVEL	1″	1⅜″	**4″**
MAXIMUM SUPPLY PRESSURE	30 psi	30 psi	**100 psi**
WEIGHT	45 lbs.	45 lbs.	**25 lbs.**
SIZE	11¾″ dia. 16¾″ height	11½″ dia. 14¾″ height	**9″ dia. 14″ height.**

CC 406

Cono-Controls®

CONOFLOW CORPORATION

FOREMOST MANUFACTURERS OF FINAL CONTROL ELEMENTS

2100 ARCH STREET, PHILADELPHIA 3, PA.

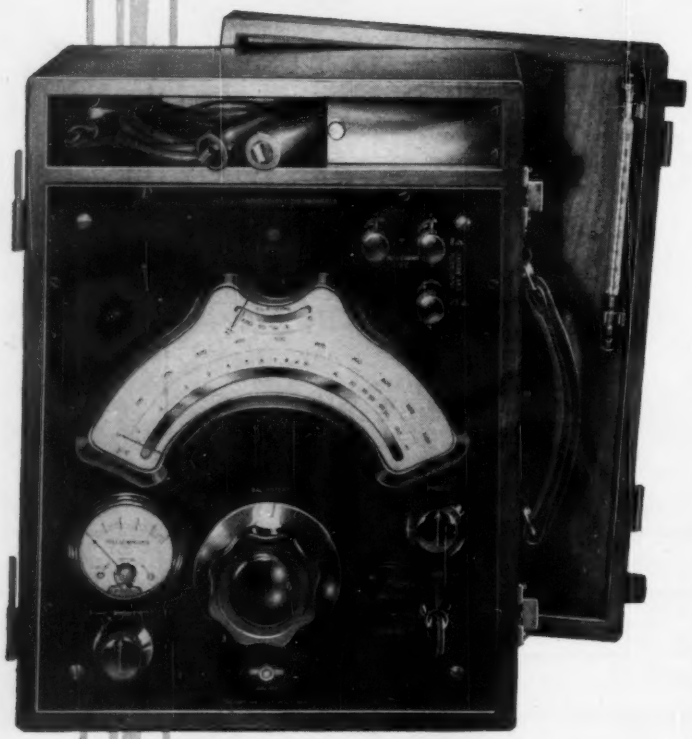
AN ACCURATE, PORTABLE, MULTI-FUNCTION INSTRUMENT

THE LEWIS *PORTABLE* TEST POTENTIOMETER

for Service Testing Exhaust Temperature Measuring Systems

Developed for use by field service engineers of a leading engine manufacturer, the Model 13P05 Test Potentiometer has proven its serviceability in desert heat and arctic cold at maintenance bases on many points of the globe.

FOUR PRECISION INSTRUMENTS IN ONE!



Model 13P05

A PYROMETER-POTENTIOMETER
for measuring exhaust thermocouple temperatures that is truly portable with a sturdy pivoted galvanometer and without a standard cell. Accurate automatic electrically operated cold junction compensation permits this instrument to be used in ambient temperatures from below freezing to plus 120°F. Mirror scales with precise hand-drawn graduations and knife edge pointers insure accurate readings from zero to 1000 degrees Centigrade.

A LOW RANGE OHM-METER
with a widely spaced, hand drawn scale for checking the resistance of leads, thermocouples and balancing resistors to insure correct adjustment to match external resistance requirements of exhaust temperature indicators, either eight or twenty-two ohms.

A KILO-OHM METER,
energized by a 67½ volt battery for checking insulation resistance of lead-wires and thermocouples. Due to the potential applied, this circuit is more effective in detecting flaws than conventional ohm meters. A hand-drawn scale is clearly marked in kilo ohms resistance.

A THERMOMETER TESTER
for precise scale error checks of exhaust temperature indicators having either eight or twenty-two ohms external resistance. A controlled power supply energizes the indicator under test, through the correct series resistance, and the zero to 1000°C temperature scale is used as a reference standard. Recommended for use in adjusting exhaust indicators in accordance with ambient temperature, with power applied for 700°C, through the proper resistance. A liquid-in-glass thermometer and flexible test leads are supplied with each instrument.

For dependable maintenance, use test equipment made by the manufacturer of the components to be checked.

LEWIS ENGINEERING CO.

NAUGATUCK, CONNECTICUT

For more information circle **11** on inquiry card.

Trends...

INSTRUMENTS and AUTOMATION

Foreign instrument markets are being evaluated by Department of Commerce to establish size and growth potential for scientific, lab, and industrial instruments. Report on Australia says that Australia produced 12 million pounds ($27 million of instruments in 1951-52; and imported 10.8 million pounds ($24 million) of instruments in 1953-54. U. S. was outranked by three countries as source of supply—U. K., Switzerland, and W. Germany.

Population trends: Earth's population in 500 A.D. was 300 million; in 1650 it was 600 million; in 1850 it was 1.2 billion; in 1950 it was 2.4 billion. Rate is increasing.

Employment trends: Available U. S. labor force (according to U. S. Census Bureau) is now about 65 million and growing at rate of 1 million per year. "Safe minimum" of inevitable unemployment is 3 to 5% of total, or about 3 million. Census figures for Nov., 1954 report 2.89 million unemployed, as compared to 1.24 million unemployed in August, 1953.

Several hundred laboratories in U.S. are now specializing in electroencephalography (brain wave analysis). Analysis of the electric signals, the major problem, is being attacked by electronic wave analyzers, "toposcopes" (CR tube analogs), etc.

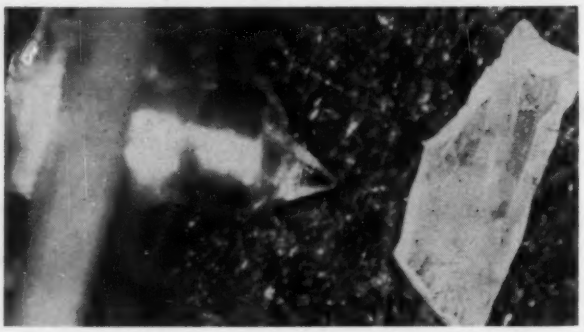
Underground storage of petroleum products is expanding. Since 1950, storage capacity for liquefied petroleum products has increased to nearly 10 million barrels. Heating oils, aviation fuels, and other products with seasonal demands but continuous production are being stored underground. Instrumentation of underground reservoirs will expand rapidly.

Analog computers offer industrial engineers, for the first time, direct means for increasing efficiency via analysis of unit operations and control systems. Key to such use is development of transfer function descriptions of each unit operation. Watch for increased emphasis on transfer functions.

Highlights of an expanding industry: Beckman Instruments, Inc., has bought Specialized Instruments Corp. and Spinco Service of Belmont, Calif.; Leeds & Northrup begins construction of new $2.7 million plant at N. Wales, Pa.; Midwestern Geophysical acquires new 78,000-sq.-ft. plant and changes name to Midwestern Instruments; Servomechanisms announces new 48,000-sq.-ft. $500,000 plant at Los Angeles International Airport; Liston-Becker is doubling manufacturing space for infrared analyzers; Penn Industrial Instrument Corp. will merge with Burgess-Manning Co. of Libertyville, Ill.; Fairchild C & I announces new plant in Los Angeles; Weksler Thermometer occupies new plant in Long Island, N. Y.; Fielden Instrument Div. of R-Fulton triples facilities in Phila.; Electronic Research Associates doubles facilities in N. J.; Scott Testers erects new plant in S. C.; Petz-Emery, Inc., is new instruments firm in Pleasant Valley, N. Y.

Imports of optical instruments totaled 43.7% of total U.S. market in 1953, according to brief filed by Scientific Apparatus Makers Association before Committee on Reciprocity Information in Washington. This compares with 1% in 1947. SAMA reports that 1500 optical workers are now displaced or unemployed.

Man-made Diamonds



SCHENECTADY, N. Y.—Diamonds made in the GE Research Laboratory crown 125 years of effort by scientists in many countries to duplicate nature's hardest and most glamorous crystals. Shown above is the largest diamond yet made in the General Electric Research Laboratory, by Dr. Herbert M. Strong, physicist. About 1/16th of an inch in longest dimension, it has been photographed beside a standard, diamond, high-fidelity phonograph needle to indicate its relative size.

Reaction to this momentous development included a $4 jump in GE stocks— and a drop in the diamond market, although the man-made diamonds are suitable at present only for industrial use.

Success in making diamonds at GE came after more than four years of effort. Tested for hardness, the GE diamonds proved to be the first man-made substance able to scratch other diamonds. Pressures greater than 100,000 atmospheres (1,500,000 psi.) were achieved, and temperatures above 5000 deg. F. were maintained for long periods. Some processes produced diamonds in minutes. Single runs of the press have yielded solid clusters containing as much as 1/10th carat.

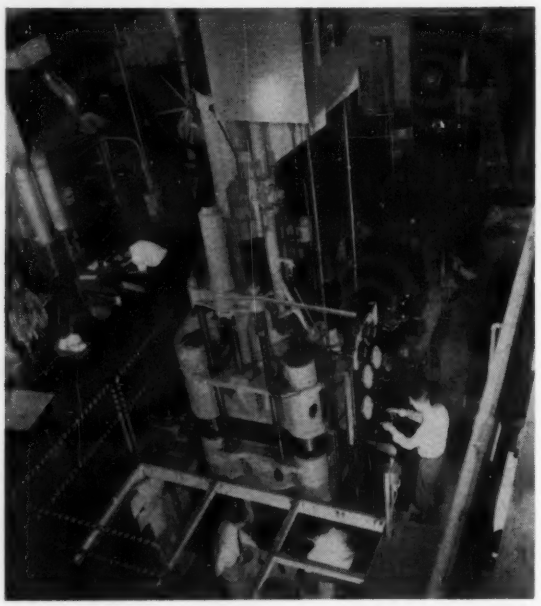
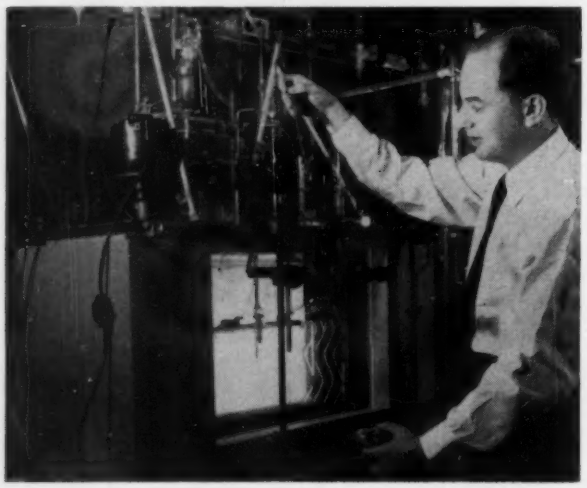


Illustration shows 1000-ton press, for achieving pressures of 1.6 million psi., in which man-made diamonds were first produced.

Hydraulic Balance

TOLEDO, OHIO.—Institute of Silicate Research at the University of Toledo reports a novel method for the measurement of extremely small forces acting upon immersed solid samples. The method was devised by Dr. Wolfgang Haller who designed what he calls a "Pressure Controlled Hydraulic Balance."



Main components comprise a pressure system, an accurately controlled constant temperature bath housing the reaction chamber with the immersion liquid, and the sample carrier (a nickel screen basket suspended from a pressure-sensitive glass float). The glass float is an outgrowth of the Cartesian Diver in the respect that its bouyancy is a function of the hydrostatic pressure.

Dr. Haller reports that it was possible to measure continuously the weight loss of silicate glasses due to corrosion by water with an accuracy of 3 parts per million. The reported accuracy was obtained while controlling the temperature of the balance within 0.0001 C.

Course In Spectrography

BOSTON, MASS.—Boston College has announced a special two-weeks intensive course in Modern Industrial Spectrography at Chestnut Hill, Boston, Massachusetts, from July 11 to July 22. The course is particularly designed for chemists and physicists from industry who are desirous of learning the techniques of emmision spectroscopy as an analytical tool. An optional third week of laboratory practice will be made available to those who desire it. Information on the course may be obtained from Professor James J. Devlin, S. J., Physics Department, Boston College, Chestnut Hill 67, Mass.

ASCO

one source for the most complete line of SOLENOID VALVES

When you discuss solenoid valve requirements with an ASCO Engineer, you are benefiting from the design and development experience of half a century. The ASCO specialist can recommend the *right* valve for your needs because that leadership has resulted in the more than 1300 types of solenoid valves now available:

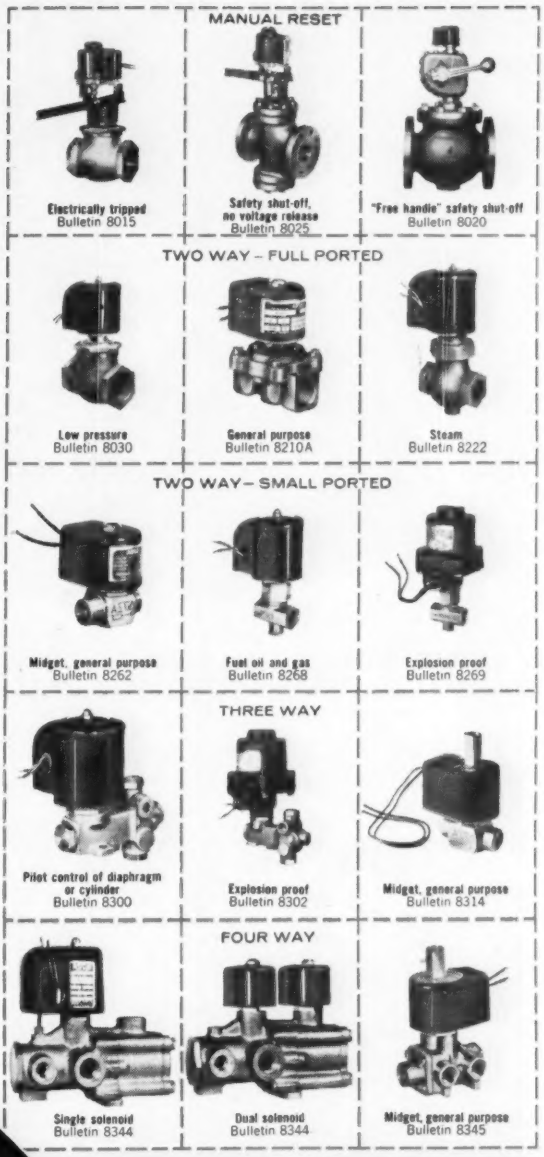
Two way valves in pipe sizes from ⅛" to 6" – for temperatures to 600° F. – for pressures to 1500 p.s.i.

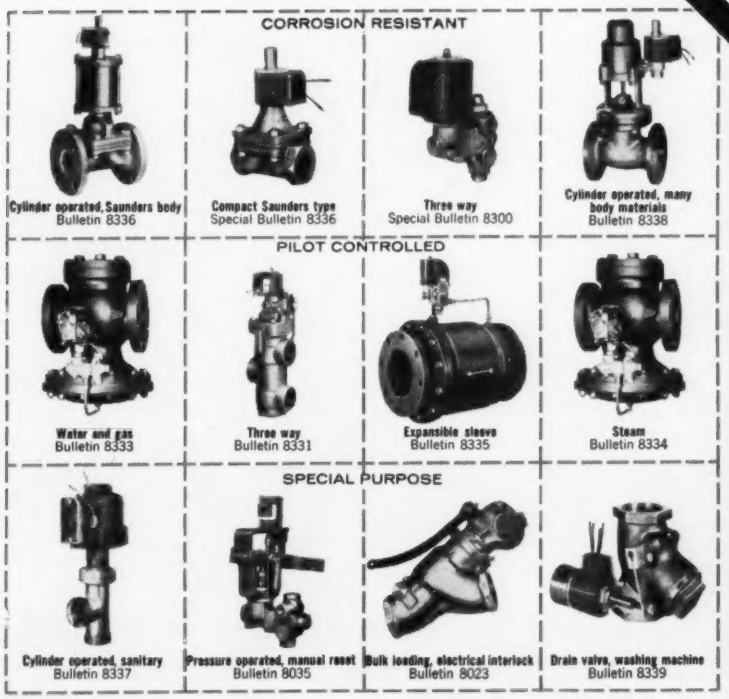
Three way valves in pipe sizes from ⅛" to 6" – for temperatures to 450° F. – for pressures to 1000 p.s.i.

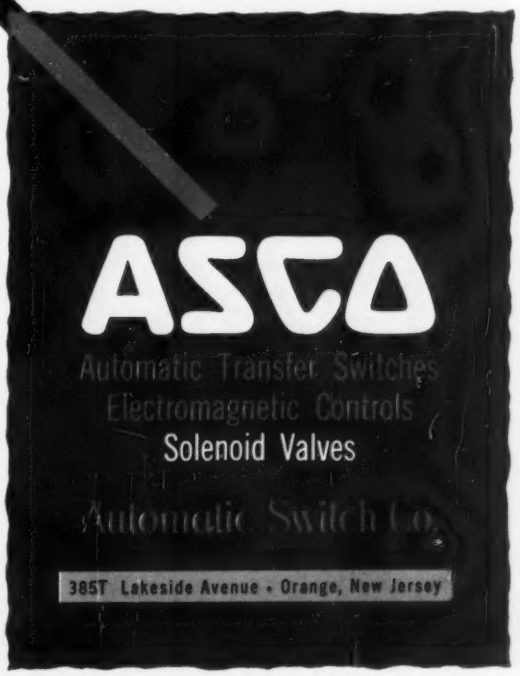
Four way valves in pipe sizes from ¼" to 1½" – for temperatures to 212° F. – for pressures to 500 p.s.i. – poppet or slide type.

And ASCO can supply you with standard, explosion-proof or water tight enclosures – Class A and Class H coils – a wide range of body materials including cast iron, brass, bronze and stainless steel.

There's *one* source that solves virtually any solenoid valve problem – ASCO. Why not have the ASCO Engineer call – or write for your copy of ASCO Solenoid Valve Catalog No. 24.







For more information circle **12** on inquiry card.

WHAT'S NEW AT BRISTOL...

Don't be without this free pyrometer reference book!

If you use pyrometers, this fact-filled 56-page booklet is a "must". Its three sections tell you quickly everything you want to know about thermocouples and all other pyrometer accessories.

Chock-full of money-saving ideas, informative illustrations, charts, and detail drawings, this well-indexed book does these three jobs:

HELPS YOU SELECT THE RIGHT THERMOCOUPLE, wire, and protecting tube for every installation. Complete information on all thermocouples and radiation pyrometers, with installation suggestions.

HELPS YOU KEEP THERMOCOUPLES ON THE JOB. Complete, well-tabulated descriptions of replacement parts and accessories, with simple ordering instructions.

HELPS YOU GET QUICK, ACCURATE CALIBRATION DATA. Calibration tables for all commonly used thermocouples, in Centigrade and Fahrenheit scales. 4.18

Mail the coupon today for your free copy!

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Send me a free copy of your pyrometer fact book.

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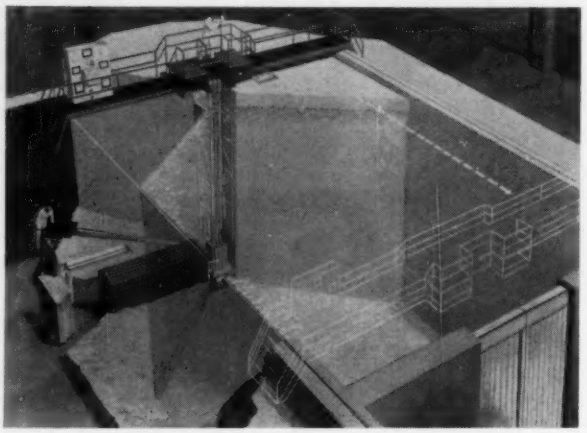
NEWS—CONTINUED

First Industry-owned Nuclear Research Reactor

NEW YORK, N. Y.—American Machine & Foundry Co., New York 16, N. Y., has completed plans for the building of the first nuclear reactor to be owned and operated by private industry for research in industrial fields.

A number of leading industrial concerns have been invited to participate in the program on a cooperative

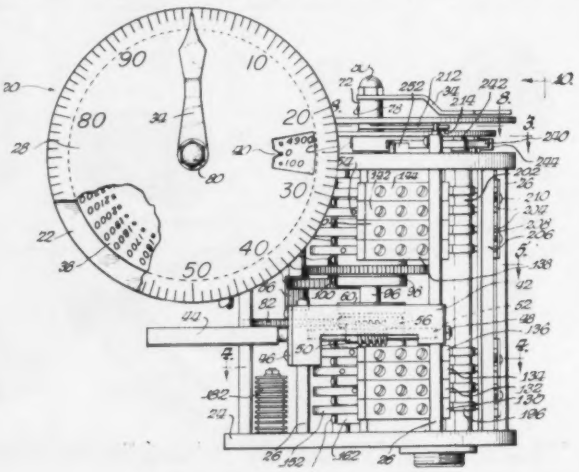


basis. Each company will be represented on a Board of Directors which will establish policy for the operation of the reactor facility. Participating companies will be from the electronics, petroleum, food, pharmaceutical, chemical, ceramics, rubber, metals, textile, agricultural, machinery, and other industries.

The first reactor (a swimming-pool type) and its supporting laboratory facilities will cost between $1,000,000 and $1,500,000 and can be constructed and available for use within 18 months. It is planned that the facility will be built in the New York area on a site of approximately 250 acres.

Multi-stop Predetermined Counter

CHICAGO, ILL.—A. E. Gersch, Chicago, has assigned the rights to a multi-stop predetermined counter to Geo. Stevens Mfg. Co., Chicago. The device counts and then



FISHER®
TYPE 16530
30,000 PSI
CONTROL VALVE
(actual photo unretouched)
Dual operators—independent action—either or both may take independent signals from instrument for automatic operation, or from manual loading station. Motion reduction accomplished through ball bearing screw-jack. Equipped with pneumatic valve position transmitter. Maximum orifice size ⅛" for 30,000 psi pressure drop.
FISHER GOVERNOR COMPANY MARSHALLTOWN, IOWA
WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL
FISHER
Our 75th
ANNIVERSARY

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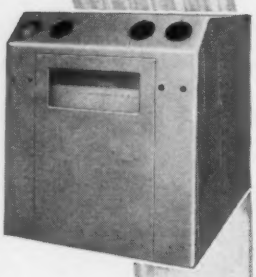
CUSTOM-BUILT
Cubicles, Cabinets and Control Boards
by Kirk and Blum

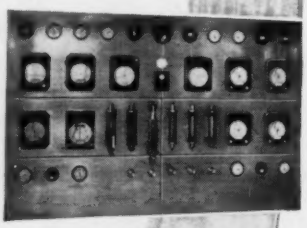
As you want it...
When you want it...
Gauges from 3/8" or lighter



● Whatever your requirements in electrical enclosures KIRK & BLUM is equipped to fabricate them to your most exacting specifications. Whether it's a single unit . . . or hundreds . . . KIRK & BLUM has the organization, experience and facilities to do a first class job.

Sheet metal units fabricated by KIRK & BLUM follow the customer's specifications accurately, down to the last detail.

We specialize in custom-built parts and assemblies of Sheet Steel and Light Plate, Stainless, Aluminum, Monel, and other alloys.



Send your prints for prompt quotation to THE KIRK & BLUM MFG. COMPANY, 3111 Forrer Street, Cincinnati 25, Ohio.

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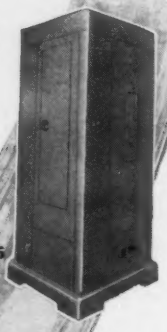
MADE TO YOUR EXACT SPECIFICATIONS

- CONTROL DESKS AND PANELS
- SWITCH GEAR HOUSINGS
- CUBICLES
- TRANSFORMER HOUSINGS AND TANKS
- ELECTRICAL ENCLOSURES
- VENTILATING LOUVRES



WE BRING YOUR DRAWINGS TO LIFE!

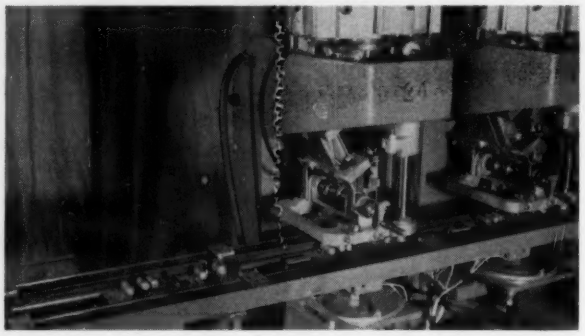
For more information circle **15** on inquiry card.

NEWS —CONTINUED

stops at any number of predetermined points—such as 15, 90, 224, 310, 15,247, etc.—as might be desired in putting taps on a coil, or changing patterns in a knitting mill, or controlling a production line. The counter can be furnished with any number of stops within the range of the counter. The counting shaft is geared to actuating discs which operate precision snap switches. The switches actuate within 0.003 second.

Automatic Assembly Machine

MINNEAPOLIS, MINN.—The first automatic assembly machine for attaching diverse electronic components to printed circuits has been developed and sold by the Mechanical Division of General Mills, Inc., to Inter-

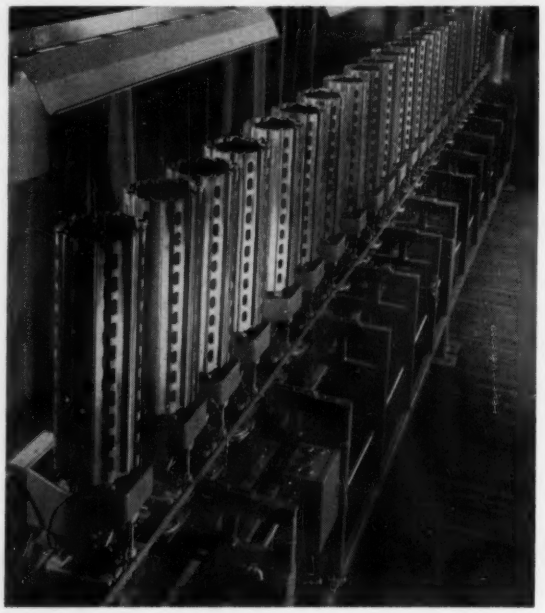


national Business Machines Corporation. It is the first such sale and delivery in the history of America's electronic industry.

The machine, called "Autofab," will be used by IBM in production of printed circuit sub-assemblies for giant air defense computers the firm is building for the U. S. Air Force. Each of these computers requires thousands of these "building block" circuits.

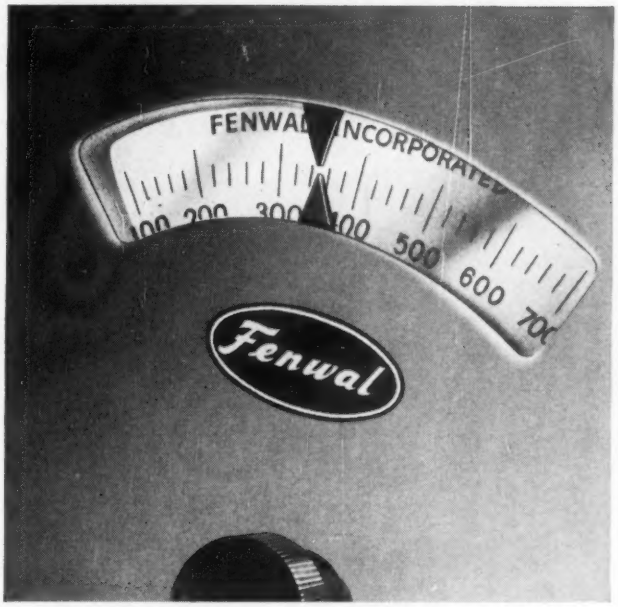
The "Autofab" machine has an estimated capacity of more than 200,000 assemblies a month—based on a 40-hour week. Three people—two operators and a supervisor —can operate the basic "Autofab" machine.

In operation, the base assembly plate moves on a conveyor under the 24 magazines. Each magazine contains a component (resistor, capacitor, etc.). The plate stops



Now . . . a new Temperature Indicator-Controller by Fenwal

1. FENWAL'S NEW SERIES 540 is a remote Temperature Indicator-Controller that combines low cost with high accuracy over a temperature range of 100° to 700°F. Designed for ovens, packaging and processing equipment of all types, the new controller operates on a liquid-filled bulb and capillary system whose response to temperature changes is transmitted through a bellows to an indicating pointer. It may be flush-mounted or surface-mounted.



2. "SET" AND "CHECK" ARE EASY. Temperature setting pointer and bulb temperature pointer pivot on the same axis, indicating against the same scale face. This permits "glance" comparison of actual and set-point readings at considerable distance from the dial. An adjustable differential, variable between 0.8% and 4% of scale range, permits adjusting the operating bandwidth to balance closeness of control against slower cycling and longer equipment life.

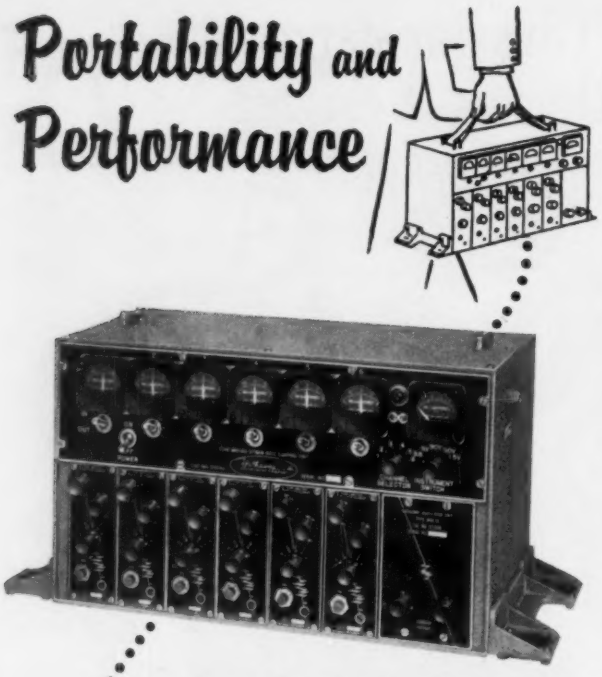
3. ACCURACY IS ASSURED. Temperature indication is accurate to within 3% over the 100° to 700°F range, including the effects of ambient temperature in the range of 50° to 150°F. Accuracy increases for narrower ranges. Uniform control and accurate calibration are maintained with typical Fenwal precision in this new, popular-priced addition to a famous line of temperature control and detection devices.

4. SEND FOR NEW BULLETIN. Get all the facts on how closely the new Series 540 meets your requirements for an economical, accurate indicator-controller. Write for comprehensive bulletin MC122. And remember, we're always ready to help in any problems concerning temperature control and detection. **Fenwal Incorporated, 363 Pleasant Street, Ashland, Mass.**

Fenwal Controls Temperatures . . . *Precisely*

For more information circle **16** on inquiry card.

Portability and Performance



HATHAWAY

TYPE MRC-12

STRAIN GAGE CONTROL UNIT

FEATURING:

- Operation from self-enclosed batteries
- 6-channel
- Frequency response, 0 to 500 cps with Hathaway Oscillographs
- Phase-sensitive demodulator
- Complete with balancing and calibrating controls

VERY ECONOMICAL

Delivery in three weeks

Hathaway Matched Transducers are available for acceleration and pressure

Ten years Leadership in Dynamic Analysis Systems

Hathaway INSTRUMENT COMPANY

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DIVISION OF HAMILTON WATCH COMPANY

Please send me your Bulletin 3A1-H on Hathaway Type MRC-12 Portable Strain Gage Control Unit

Name.....

Firm.....

Address.....City.....State.....

For more information circle **17** on inquiry card.

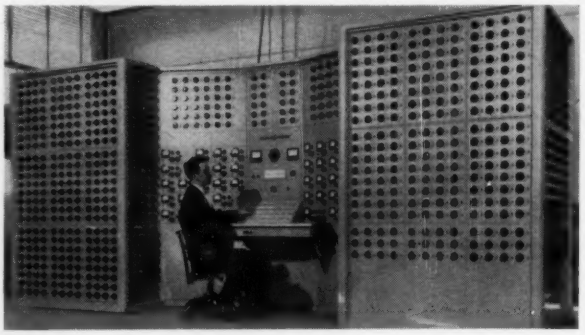
under each magazine for a brief interval while the component is automatically attached to the base plate. The system is not tailored to a single circuit and is completely flexible.

Nuclear Research Reactor

COLUMBUS, OHIO.—American Machine & Foundry Co., New York 16, N. Y., was awarded a contract by Battelle Memorial Institute, Columbus, Ohio, for the design, engineering and construction of a nuclear research reactor. The reactor will be a key component in a research center Battelle is building 15 miles west of downtown Columbus. It will be a solid-fuel type employing a core similar to that in the Materials Testing Reactor at the National Reactor Testing Station in Idaho. This type research system is the only one which has successfully operated at the high flux levels required for industrial development work.

Power System Computer

COLUMBUS, OHIO.—A dial-studded new computer that mathematically models a complex electric power system is given its first test run by K. R. Geiser, General Electric Co. computer engineering supervisor. Recently



installed in the "nerve center" of the giant American Gas and Electric System at Columbus, Ohio, the computer's 1,290 dials are set to simulate physical facilities and load conditions in AGE's 46,000-square-mile service area. It is expected to save AGE up to possibly $100,000 annually by instant computation of the most economical means of generating and transmitting electric power along nearly 8,400 miles of high-voltage transmission lines.

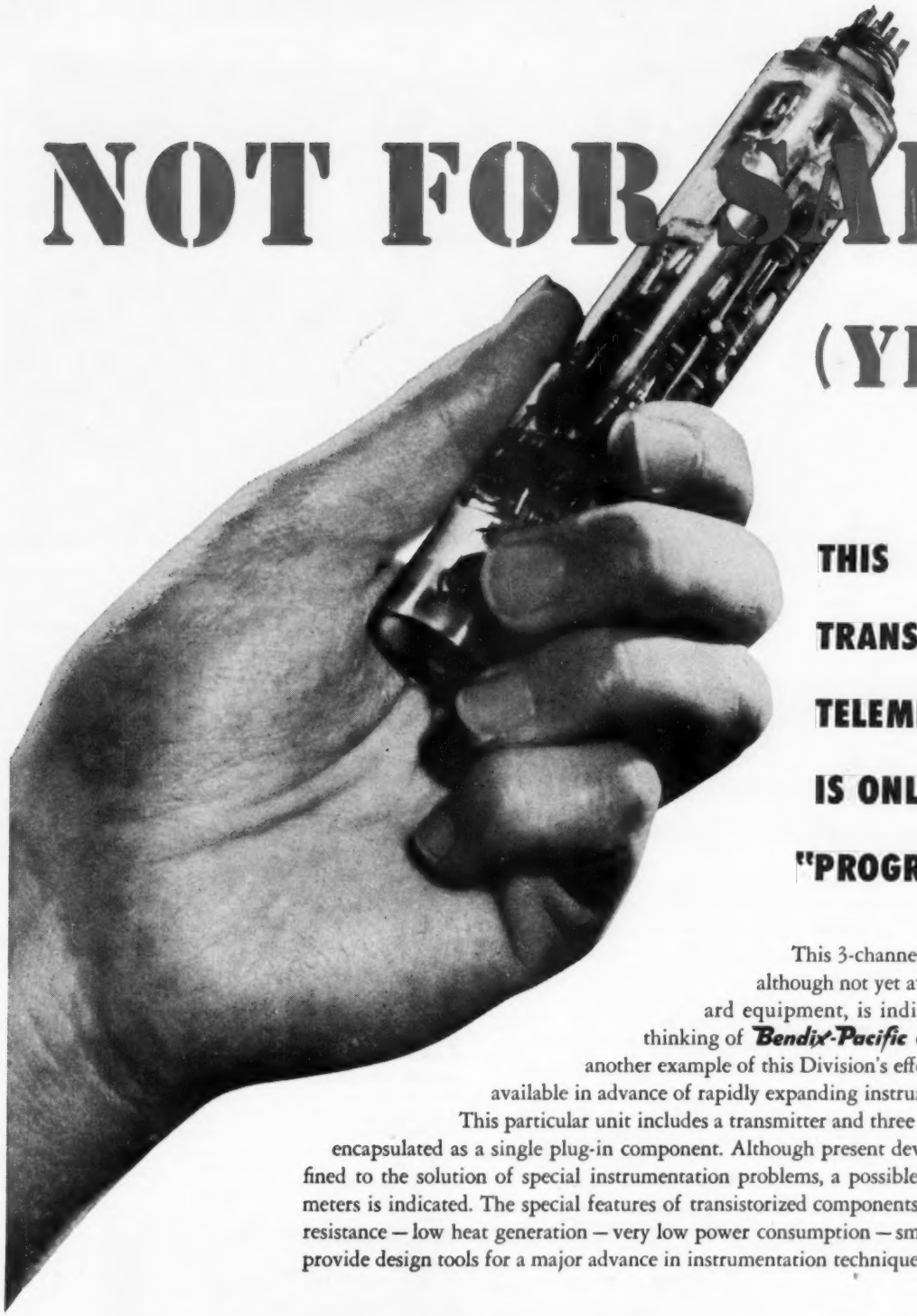
AGE cooperated in the design of the device, which was built by the G. E. General Engineering Laboratory, Schenectady.

Electronic Reliability Predictions

SILVER SPRING, MD.—Engineers at the Silver Spring, Maryland, laboratory of Vitro Corporation of America are developing methods for predicting the reliability of electronic equipment still on the drawing board or in rudimentary form. Their prediction methods are being developed from a correlation of equipment failure history with design features of the equipment. Vitro engineers are analyzing voluminous Navy records and supplementing these records by their own observations aboard ships. They have obtained significant information on the quantitative relationship of failure rates and design.

NOT FOR SALE!

(YET)



THIS TRANSISTORIZED TELEMETER IS ONLY A "PROGRESS REPORT"

This 3-channel transistorized telemeter although not yet available for sale as standard equipment, is indicative of the advanced thinking of ***Bendix-Pacific*** engineers and represents another example of this Division's efforts to have new designs available in advance of rapidly expanding instrumentation requirements. This particular unit includes a transmitter and three subcarrier oscillators, all encapsulated as a single plug-in component. Although present development has been confined to the solution of special instrumentation problems, a possible pattern for future telemeters is indicated. The special features of transistorized components — extremely high shock resistance — low heat generation — very low power consumption — small size — light weight — provide design tools for a major advance in instrumentation techniques.

Imagination at Bendix-Pacific today is building better products for tomorrow.

BENDIX ★ PACIFIC ★

THE NAME Bendix AVIATION CORPORATION MEANS TRUST

PACIFIC DIVISION • Bendix Aviation Corporation

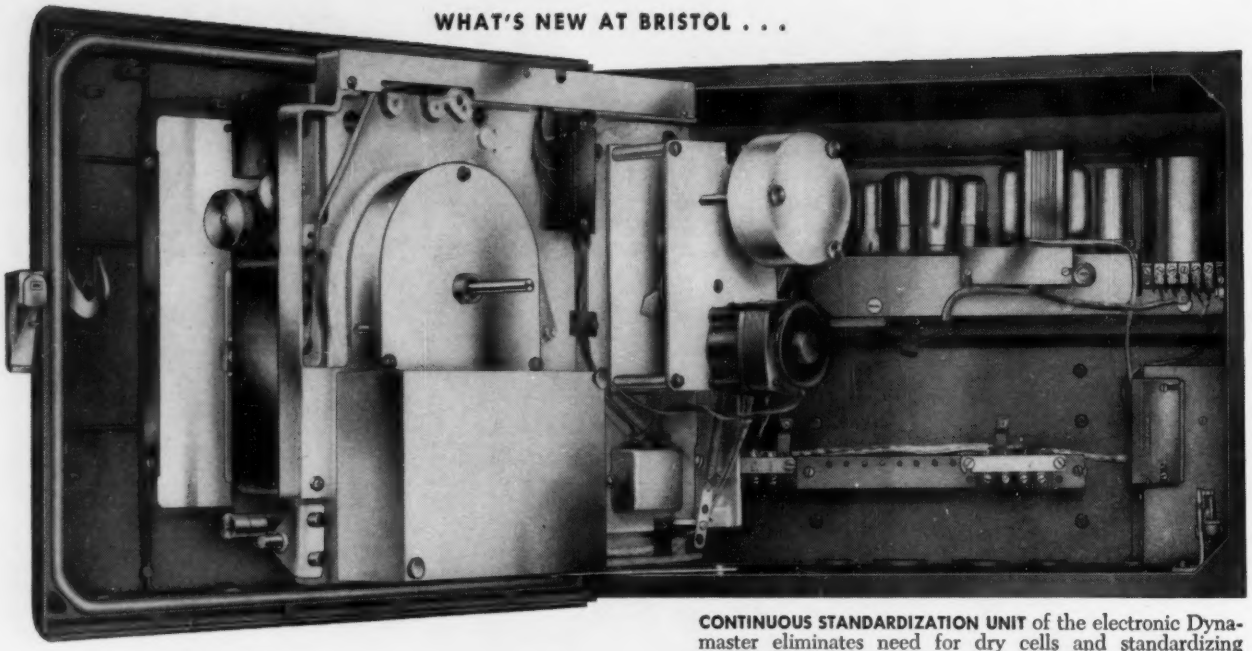
11600 Sherman Way, North Hollywood, California

Good positions are available at all levels for Electronic Design Engineers. Contact W. C. Walker, Engineering Employment Manager.

East Coast Office:	Dayton, Ohio	Washington, D. C.	Canadian Distributors:	Export Division:
475 5th Ave., N. Y. 17	1207 American Blvd., Dayton 2, Ohio	Suite 803, 1701 "K" St., N. W.	Aviation Electric, Ltd., Montreal 9	Bendix International 205 E. 42nd St., N. Y. 17

For more information circle **18** on inquiry card.

WHAT'S NEW AT BRISTOL . . .



CONTINUOUS STANDARDIZATION UNIT of the electronic Dynamaster eliminates need for dry cells and standardizing mechanism. Result: no interruptions in the operation of the potentiometer for standardization; no batteries to replace.

No time out for standardization here

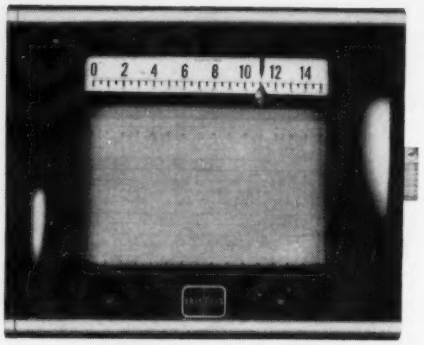
Bristol Dynamaster potentiometer pyrometers give you No-Batt continuous standardization

• You don't have to put up with interrupted performance from old-fashioned potentiometer pyrometers any longer!

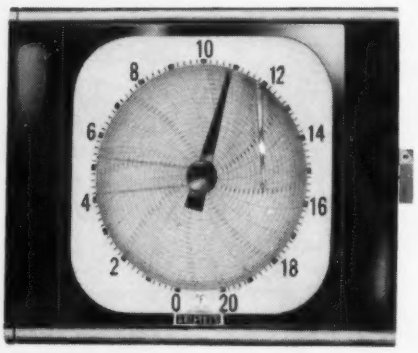
When you use a Bristol thermocouple or radiation-type Dynamaster, you get a *continuous* record or control of temperatures up to 4000°F in any type of fuel-fired or electric furnace or heating equipment. Thanks to the exclusive No-Batt continuous standardization which eliminates the need for dry cells in these electronic instruments, Bristol has been able to do away with interruptions formerly required for periodic standardization.

Bristol electronic Dynamasters are made in round- and strip-chart, single- and multiple-record recorders, air-operated and electric controllers with all types of control actions. Two-pen and program control.

For the complete story on the modern human-engineered Bristol Dynamaster, write for free 35-page booklet P1245. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.



BRISTOL DYNAMASTER CONTROLLERS in either the strip-chart model (shown above) or round-chart model, may be electrically or air operated. 2 position, 3 position, proportional, manual with automatic reset, or proportional input controls. On - off, proportional or reset air controls.



BRISTOL DYNAMASTER RECORDERS come in easy-to-read round-chart (shown here) or strip-chart models. Single record, multiple record or continuous 2 record designs are available. Bristol also supplies all types of time-temperature program controllers.

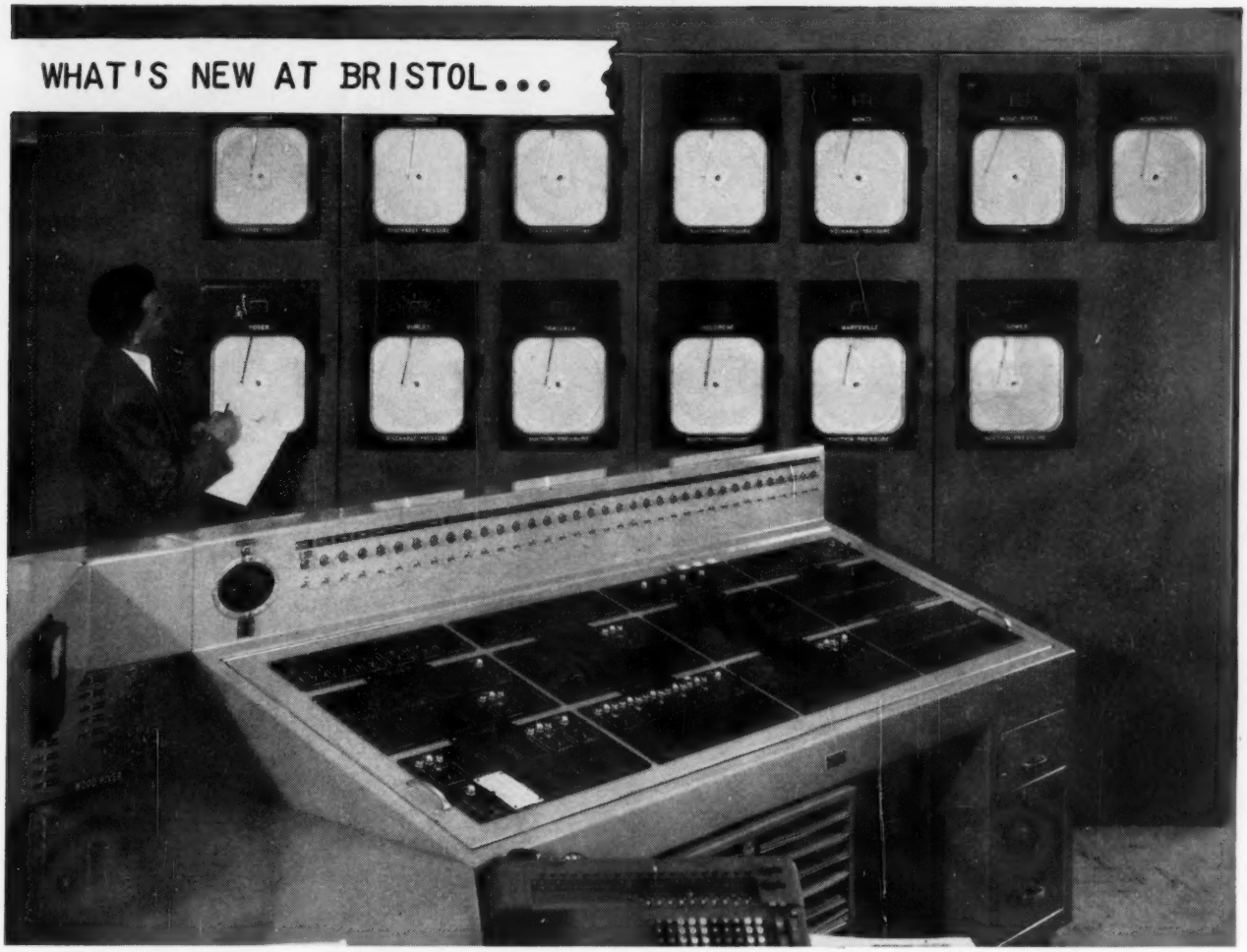
BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **19** on inquiry card.

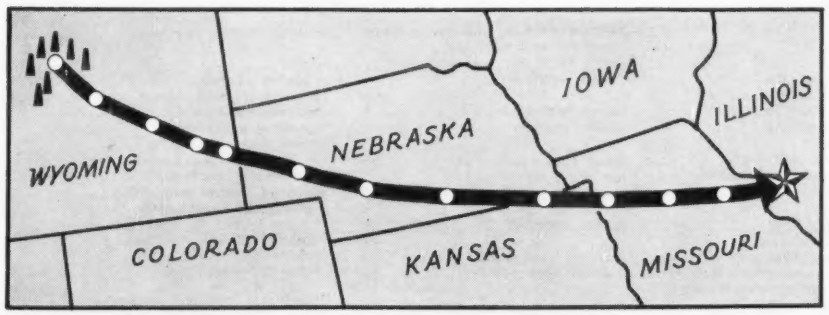
WHAT'S NEW AT BRISTOL...



BRISTOL METAMETER* TELEMETERS in the Kansas City office of the Platte Pipe Line Company continuously record suction and discharge pressure, flow, and static pressure all along Platte's 192,500 b/d crude oil pipeline. Operations in the 1000-mile network of pipe are controlled from this central dispatching office – a situation made possible by continuous measurement at critical points.

* Reg. U.S. Pat. Off.

Taking the pulse of a 1000-mile pipeline



FROM THE ROCKIES to St. Louis, crude oil is monitored every foot of the way by Bristol instruments.

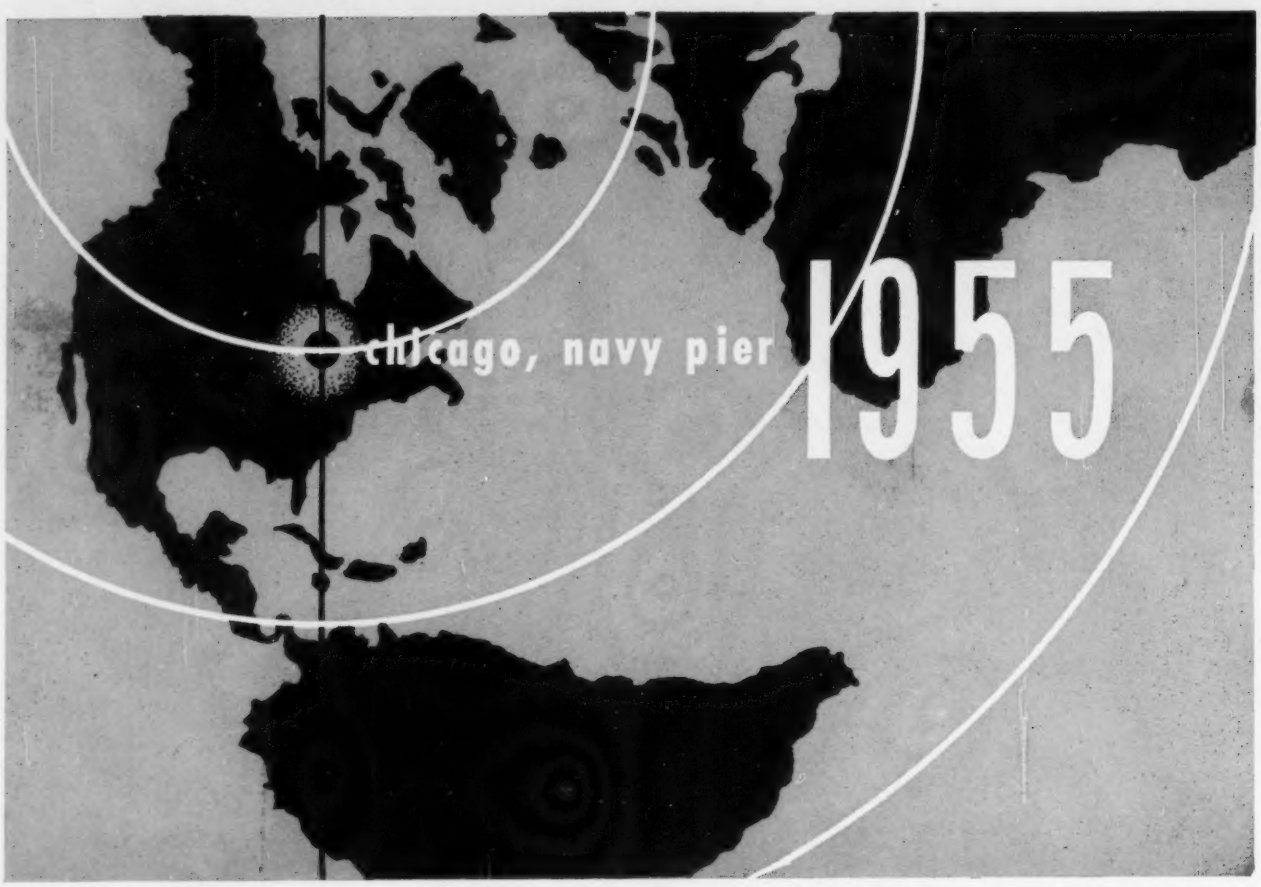
Why did Platte select Bristol Metameter Telemeters for their 1000-mile pipeline? Simply because it's good business to do business with Bristol – acknowledged leader in telemetering for over 43 years. Drop us a line today for the whole Bristol story. Write The Bristol Company, 113 Bristol Road, Waterbury, Conn. 4.40

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **19** on inquiry card.



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Can be Displayed to Advantage

Analog-to-digital converters
Analytical control equipment
Automatic control valves
Automatic control systems
Automatic feeding devices
Automatic gaging equipment
Automatic handling equipment
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Automatic loaders
Automatic machine controls
Automatic tape controls

Beta-ray thickness gages
Brakes, clutches and drive mechanisms

Central control systems
Color process controls
Communication systems including closed circuit television, telephone and paging systems
Compressors for automation air
Computers, analog or digital
Computer components
Continuous gas analyzers
Continuous testers

Conveyors
Counters

Data processing and data reduction systems
Data transmission and computing systems
Decade counters
Door operators, automatic
Dust and atmosphere controls

Electric motors
Electronic computers
Electronic control devices
Electronic, electrical and mechanical components for automatic production systems

Gages, air
Governors

Hydraulic cylinders and motors

Indexing machines
Industrial television, closed circuit
Infrared absorption analyzers

Instrumentation and automation panels and cubicles
Instruments for measurement and control

Level controllers
Limit switches

Mass spectrometers
Metering equipment
Monitoring systems
Monorails
Motor controls

Optical gages and inspection devices

Packaged servo controls
Photoelectric control devices
Pneumatic tubes
Positioning equipment
Power supplies
Printed code readers

Radioactivity equipment
Recording equipment

Remote control systems

Scales
Scanning systems
Servo-components
Servomechanisms
Signalling equipment
Speed controls
Strain measuring devices for automatic control
Switches, relays and other electrical components

Teleprinters and facsimile recorders
Two-way radio

Ultraviolet absorption analyzers

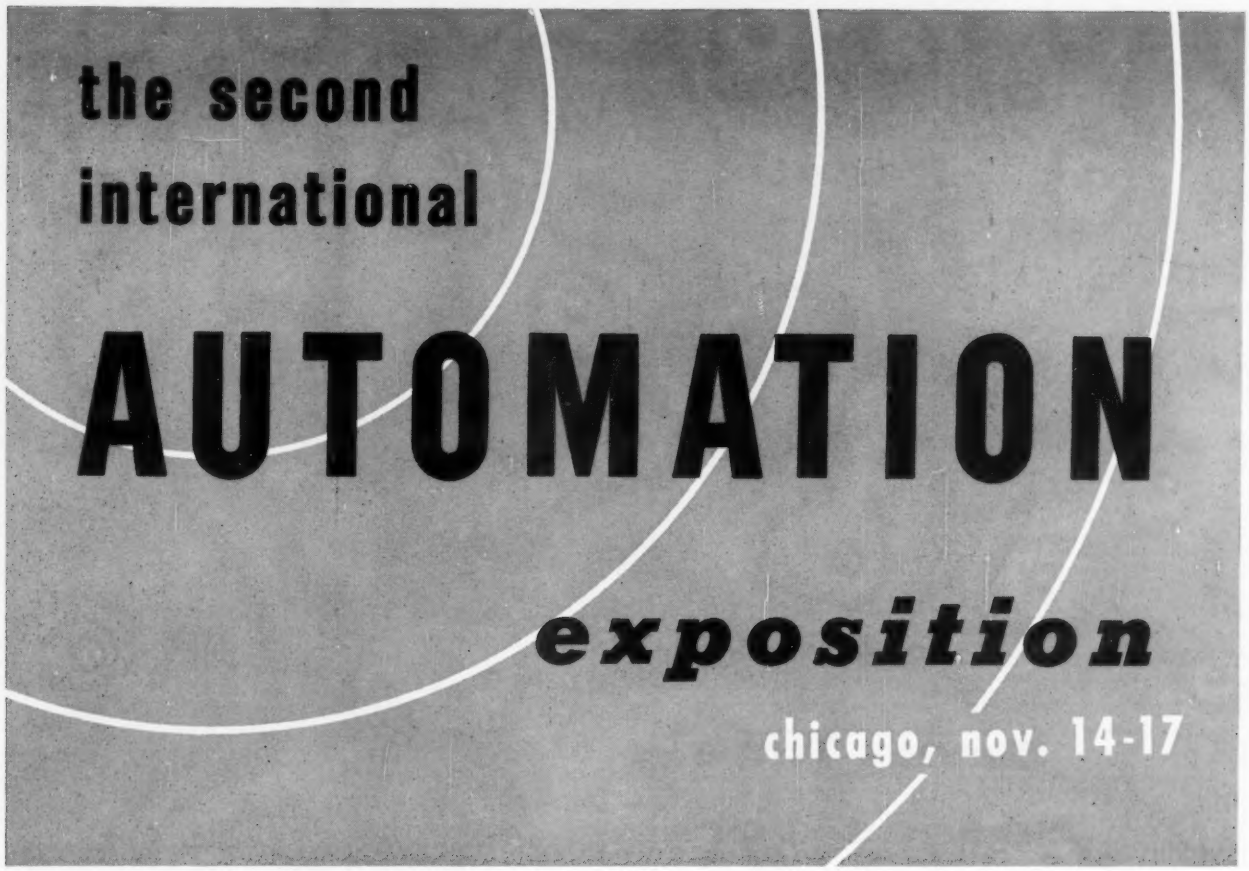
Vibration control equipment

Weighing and proportioning equipment
Work positioning mechanisms

X-ray and flouroscopic devices
X-ray gages

For more information to help in planning your exhibit write to: The Second

For more information circle **20** on inquiry card.



For what promises to be the most important event in

AUTOMATIC CONTROL
AUTOMATION
INSTRUMENTATION

ever held, the Second International Automation Exposition has reserved the facilities of Chicago's famed Navy Pier.

All technical sessions and clinics—including the important electronic computer clinic—will be held in the Pier's meeting rooms. Restaurant and lounging facilities, so necessary for a successful show, will be arranged in the exhibit halls.

With its ideal geographical location, Chicago will attract thousands of engineers and scientists from all over the world. For the exhibitor, the 1955 Automation Exposition will open new channels to the successful application of Automation.

International Automation Exposition, 845 Ridge Avenue, Pittsburgh 12, Pennsylvania

For more information circle **20** on inquiry card.

Quick Lever Reset

Saves Time— Speeds Work

Added Evidence that—

Everyone Can Count on VEEDER-ROOT

Where time consumed in resetting is at a premium . . . on short machine-runs, inspection, military equipment and other applications . . . this new time-tested Quick-Reset Ratchet Counter is exactly the time-saving device you need. Just depress the easy-acting lever on the right side through 45° . . . *all 4 figures reset instantly to zeros.* And a thumb-lever may be used on the left side also if the counter is to be operated manually.

This compact, standard counter, now readily available from stock, is one of scores of Veeder-Root Counters (both standard and special) for manual, mechanical and electrical operation in every field from electronics to atomics. Just name what you want to count . . . and "The Name that Counts" will help you do the job. Write:

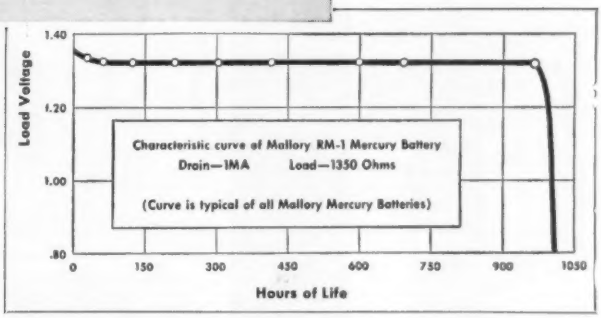
VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name that Counts"

For more information circle **21** on inquiry card.

For Constant Voltages... Use Mallory Mercury Batteries



The constant discharge voltages shown in the curves are characteristic of the uniform, dependable power delivered by Mallory Mercury Batteries. This is especially important in mobile communications equipment, hearing aids, delicate optical equipment and many kinds of instruments in which constant discharge voltages are imperative for best performance.

This is only one advantage of Mallory Mercury Batteries, however. They operate dependably at microamperes or drains of 50 amperes... intermittently or continuously... always providing a dependable, uniform source of power —even after long periods of storage.

If these characteristics will improve the operation of your equipment, then let us send you complete information. Multi-cell battery stacks and packs can be designed to fit your exact needs.

Use Mallory Mercury Batteries for applications where:

- **Constant voltage or current is required**
- **Size and weight are important**
- **Long storage periods are involved**
- **Battery leakage cannot be tolerated**
- **Wide temperature and pressure ranges are encountered**
- **Severe impact and shock is expected**

For Transistor Applications

Mallory Mercury Batteries are especially suited for transistor applications ... where constant voltage and constant current are required.

P.R. MALLORY & CO. Inc.

MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Dry Batteries
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P. R. MALLORY & CO. INC., BATTERY DIVISION, NORTH TARRYTOWN, N.Y.

For more information circle **22** on inquiry card.

CRESCENT

POLYETHYLENE

MULTITUBE

For Economy with Lasting Dependability in your Instrument Tubing Problems

CRESCENT POLYETHYLENE MULTITUBE is composed of 2 to 19, ¼" O. D. Polyethylene tubes up to 1000 feet in length, **spirally cabled together** to allow bending with a short radius without distortion of the tubes. The tubing assemblies are protected by a flexible interlocked galvanized steel armor (Type PA), or by a tough corrosion-resistant thermoplastic sheath (Type PT). One bright blue tube in each layer permits a ready identification of each tube at both ends for ease of connection.

TYPE PA—The galvanized steel armor provides complete protection from injury during and after installation. In the event of fire, the molten Polyethylene is retained within the armor.

TYPE PT—The polyvinyl chloride thermoplastic sheath provides good mechanical resistance, with complete corrosion resistance, and it is flame retarding.

Economy is achieved in the initial cost of **CRESCENT POLYETHYLENE MULTITUBE** and its accessories, as well as in substantial savings in labor costs of installation. Moderate to long length runs of light weight and compact **MULTITUBE** assemblies result in fewer connections and fittings, lower cost for supports or racks, ease of mounting, less space being used.

CRESCENT POLYETHYLENE MULTITUBE can be pulled through conduit or raceways.

Send for Bulletin giving complete information and engineering data

CRESCENT

INSULATED WIRE & CABLE CO.

OLDEN & TAYLOR STS., TRENTON, NEW JERSEY

For more information circle **23** on inquiry card.

. . . and Making **GOOD INSTRUMENTS**

Has Been Our Business For Over 40 Years

WHAT ARE *Your* TESTING PROBLEMS?

If your particular testing problem involves flow rate measurement or some similar phase of hydraulics requiring special equipment, we invite you to submit your problem to us for research and study. A description of the process involved and all pertinent specifications should be included. If in the opinion of our hydraulics engineers the basic idea is practical, we will undertake design and development of the special equipment.

DESIGNING and building Cox Precision instruments has been the full time job of Commercial Research Laboratories, Inc. for over 40 years.

The experience and specialized "know-how" we have gained is evident in the great number of Cox instruments currently being used by the automotive and aircraft industries, and by the U.S. Airforce, Army, and Navy.

Today, as in the past, scientists and craftsmen here at Commercial Research Laboratories are hard at work developing new and improved Flow-Meters, Flow-Meter Calibrating Stands, Fuel Nozzle test stands, and other Cox precision testing devices to help you in meeting tomorrow's testing problems. At the same time, we stand ready to help in designing and building the accurate precision instruments your *immediate* testing problems require — whether for the research laboratory or the production line.

An example of modern CRL service is a flowmeter service department which we have just created. Using Cox Calibrating Stands, we are able to test any make or capacity flowmeter to determine to what *exact* percentage the instrument is accurate. In cases where design of the instrument will not allow re-calibration, correction curves can be supplied to guide users in future operation of the instrument.

Commercial Research Laboratories, Inc.

20 BARTLETT AVENUE • DETROIT 3, MICHIGAN

MAKERS OF COX *SINCE 1912:* **SINGLE AND MULTIPLE STAGE FLOWMETERS • FLOWMETER CALIBRATING STANDS • CARBURETOR FLOW STANDS • FUEL NOZZLE TEST STANDS • ENGINE INDICATORS • MAGNETIC THICKNESS GAGES • VIBRATION RECORDING EQUIPMENT**

BALANCED ELECTRONIC EQUIPMENT FOR PRESSURE AND VIBRATIONS.

For more information circle **24** on inquiry card.

New

TRANSISTORIZED MINIATURIZED

TYPE 2007T

400 CYCLES ±.02%

28 VOLTS D.C.

SPECIFICATIONS

INPUT
20 to 35V DC
at approx. 5 m.a.

OUTPUT FREQUENCY
400 or 500 cycles

Type 2007T
+ —.02% from —65° to + 85°C.

Type R2007T
+ —.002% from + 15° to + 85°C.

Type W2007T
+ —.005% from —65° to + 85°C.

OUTPUT VOLTAGE
5 volts, sine wave.

Substantially uniform
from —65° to + 85°C.

LIFE EXPECTANCY
several times that of vacuum tubes

INTERNALLY SHOCK MOUNTED
on Silastic

MAGNETICALLY SHIELDED

HERMETICALLY SEALED

OCTAL BASE

SIZE
4½" x 1½" diameter

WEIGHT
7 ounces

COMPLETE INFORMATION ON REQUEST
PLEASE SPECIFY TYPE 2007T

Precision

FREQUENCY STANDARDS

These units, which are the result of several years of development and testing, offer a new standard of simplicity and reliability. Particularly noteworthy is the uniformity of output signal voltage with temperature change. Small size and light weight make them ideal for airborne and portable use.

For applications where only higher B voltages are available, a simple voltage reducing circuit may be used.

American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

MANUFACTURING UNDER PATENTS OF WESTERN ELECTRIC COMPANY

For more information circle **25** on inquiry card.

NEW...

small size, twelve-channel, precision balance adjustment

MIDWESTERN
MODEL 430
BRIDGE BALANCE UNIT

A 10-turn precision potentiometer with a series, limiting resitor is provided for each channel. Will work with any 2 or 4 arm transducer having input resistance of 120 ohm or greater.

Midwestern Instruments' new Model 430 Bridge Balance Unit is a general purpose instrument suitable for either laboratory or flight-test work. The main design emphasis was placed on producing a unit of the smallest possible size consistent with the wide versatility of operation and application which is desirable in such an instrument. The Bridge Balance Unit is contained in a rugged, aluminum-alloy case. Printed circuits have been used wherever possible throughout the instrument in order to minimize the volume. The front panel of the instrument, on which the controls are mounted, is recessed in order to provide protection against accidental movement. Means are provided for both internal and external calibration.

products

- OSCILLOGRAPHS (LABORATORY AND FLIGHT TEST)
- MAGNETIC STRUCTURES
- GALVANOMETERS
- AMPLIFIERS
- HYDRAULIC SERVOVALVES
- TORQUE MOTORS
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- DATA REPEATERS
- WATERPROOF CONNECTORS
- GEOPHYSICAL EQUIPMENT

MIDWESTERN MI INSTRUMENTS

MIDWESTERN INSTRUMENTS

41st and Sheridan Road — Tulsa, Oklahoma

For more information circle **26** on inquiry card.

Taking the "GUESS" out of Gauge Specifications

You'd be surprised how often those tough gauge problems can be solved easily by talking them over with one of USG's application engineers.

If your problem involves the handling of corrosive materials, extremes in temperatures and pressures, unique process application, or one of a hundred unknown factors, USG's wide engineering experience and facilities make possible tests under simulated operating conditions. This assures higher accuracy and maximum gauge life.

The test data available at USG may be of help to you in these and other gauge problems. Often, one of our over 200,000 stock gauges will meet your requirements . . . a real advantage from the standpoint of cost and availability. If, however, stock gauges do not serve your purpose, USG is in a position to make special gauges that will exactly fit your needs.

USG will be glad to help you solve any problem involving temperature and pressure indications. Why not call our District Office nearest you, or, send your problem directly to us at Sellersville.

UNITED STATES GAUGE USG

Gauge Headquarters
for over 50 years

United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Penna.

For more information circle **27** on inquiry card.

USG'S RESEARCH LABORATORY SIMULATES OPERATING CONDITIONS FOR OPTIMUM GAUGE PERFORMANCE

To assure optimum operating results under new or changing process conditions, USG tests gauges in its Research Laboratory under simulated operating conditions. Annually, these USG tests save customers hundreds of thousands of dollars in greater operating performance and less down time, not to mention eliminating the need for more frequent gauge replacements.

Constant testing of materials and assemblies under all kinds of operating conditions is one reason why USG gauges are renowned for their enduring accuracy and dependability. USG assures this enduring accuracy and dependability in lot after lot by employing in its manufacture one of the most rigid quality control systems in the instrument industry.

For more than 50 years USG has been designing and producing gauges for more original equipment manufacturers than any other instrument company in the world. With facilities economically integrated for large volume-quality controlled production, USG helps industry reduce its gauge costs by stocking the most complete line of gauge components to meet practically any pressure sensing or actuating need.

To assure immediate availability of standard gauges, USG maintains a large inventory of over 200,000 standard gauges in a wide variety of types, sizes and ranges.

Above, a portion of USG's Research Laboratory. Here constant testing of materials under customer operating conditions assures optimum performance and long gauge life.

Circle **28** on inquiry card. ⟶

X10,000

BRUSH

Announces . . .

NEW D.C. RECORDING AMPLIFIER WITH GAIN OF 10,000!

This new Brush Amplifier is outstanding for stability, high gain and reliability. When used with any of the Brush Oscillographs it permits instantaneous chart recordings of both low-level D.C. or A.C. voltages with full range of frequencies. The use of a chopper-stabilized feedback circuit eliminates the need for matched tubes and permits an extended frequency response. More than ever, Brush Recording Systems provide full range instrumentation for your measurement problems.

Ask your Brush representative or send coupon for complete information. Brush Electronics Company, Cleveland 14, Ohio.

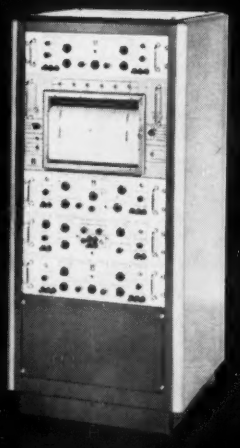
CHECK THESE FEATURES!

HIGH SENSITIVITY – 100 microvolts per chart mm.
HIGH STABILITY IN USE – less than ¼ chart mm. drift/hour.
EXTENDED FREQUENCY RESPONSE – D.C. to 100 cycles per second with Brush Direct-Writing Oscillographs. With photographic equipment, frequency range can be extended to 5,000 cps.
LOW NOISE – less than 25 microvolts equivalent input.
INPUT IMPEDANCE – 1 megohm.
INTERNAL CALIBRATION – 2 millivolts and 1 volt.

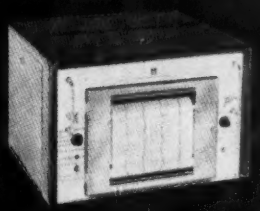
FULL RANGE INSTRUMENTATION

Brush Amplifiers and Oscillographs provide multi-channel recording of voltages from D.C. to 100 cycles per second – or of physical phenomena such as stress, strain, torque, force, temperatures, etc.

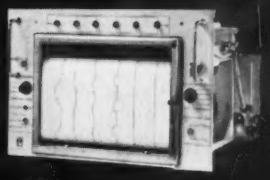
Brush Recording Systems give you the greatest flexibility in measurements. You have a choice of 8 or 16 chart speeds; ink or electric writing.



Units can be mounted in standard racks, or portable cabinets.



Four-Channel Oscillograph



Six-Channel Oscillograph

Dual-Channel D.C. Amplifier

Universal* Amplifier

*Trade-Mark

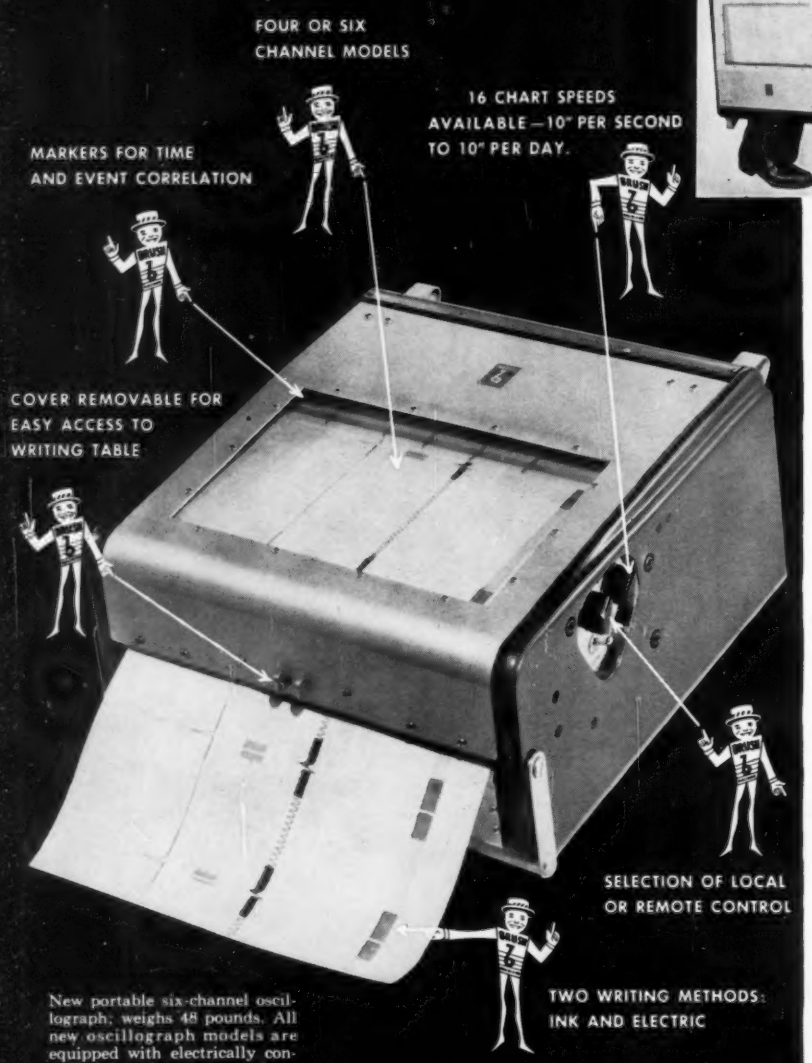
BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

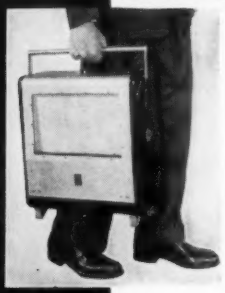
BRUSH ELECTRONICS

Division of Clevite Corporation

USE COUPON →



New portable six-channel oscillograph; weighs 48 pounds. All new oscillograph models are equipped with electrically controlled chart drive transmissions.



NOW!

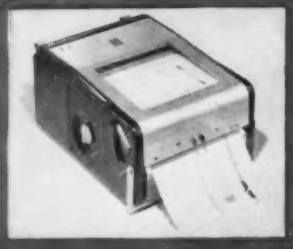
PORTABLES

JOIN THE "NEW LOOK" IN RECORDING SYSTEMS

● The new Brush Portable Recording Systems are light in weight, easy to use. In addition, they provide the full-range instrumentation for portable use now offered by Brush's line of rack and console-mounted systems.

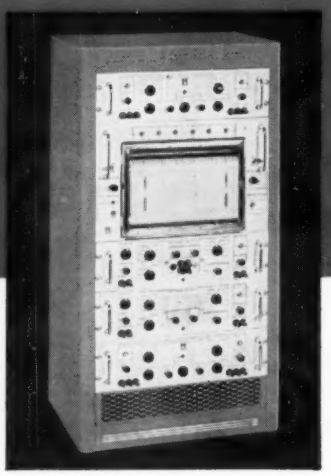
You can record a greater range of signals with optimum resolution than with any other direct-writing oscillographs. These new units have the widest chart speed range available—from 10" per day to 10" per second. Units can be equipped for both ink and electric writing.

Brush Portable Recording Systems are ideal for field tests, are easy to set up, and do not require skilled technicians. Find out how they can simplify your testing problems—electrical variables, stress, strain, torque, vibration, etc. Send coupon for booklet, or call your Brush representative for complete information.



New portable four-channel oscillograph; weighs 36 pounds.

New Universal* Amplifier with portable case.



Amplifiers can be equipped with portable carrying cases or installed directly in standard racks. Both rack-mounting and portable oscillographs have the same electrically controlled chart drive transmissions.

*Trade-Mark

BRUSH ELECTRONICS COMPANY, Dept. A-3
3405 Perkins Avenue
Cleveland 14, Ohio

☐ Please have your representative call.
☐ Please send bulletins on the following: (check below)

_____ New high gain Amplifier.
_____ Portable Recording Systems.
_____ Recording Systems for rack or console mounting.

Name _____
Title _____
Company _____
Address _____
City _____ *State* _____

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

Division of Clevite Corporation

YOU CAN PUMP IN CONTROLLED VOLUME

HYDROCHLORIC ACID... ALL CONCENTRATIONS

CHLORINATED HYDROCARBONS

CORROSIVE METALLIC SALT SOLUTIONS

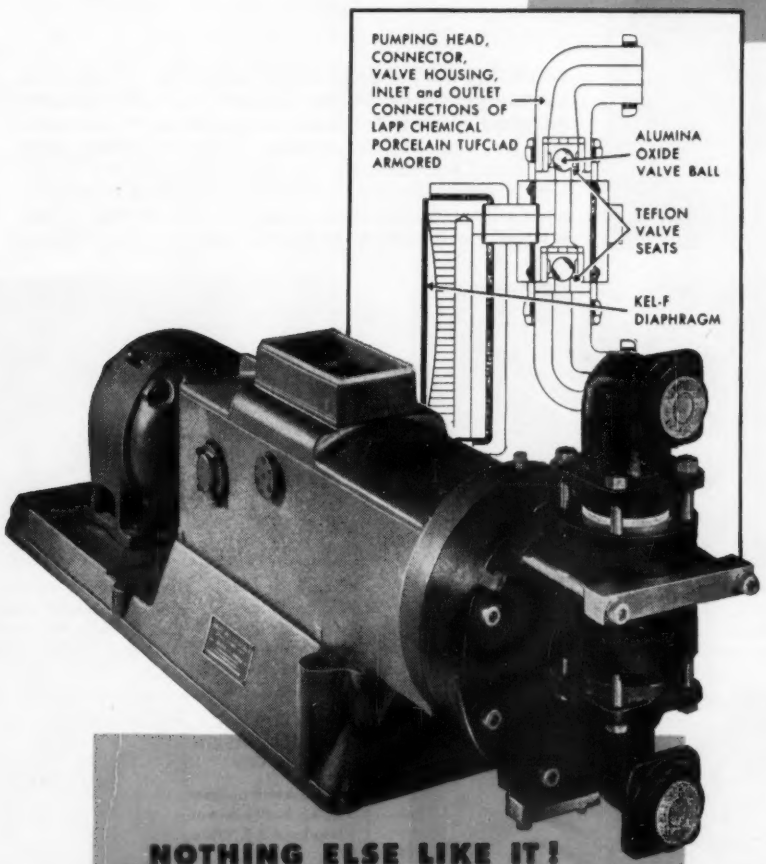
DILUTE ACIDS

MIXED ACIDS

WITH

Lapp PULSAFEEDER

COMPLETELY NON-METALLIC CONSTRUCTION


PUMPING HEAD, CONNECTOR, VALVE HOUSING, INLET and OUTLET CONNECTIONS OF LAPP CHEMICAL PORCELAIN TUFCLAD ARMORED
ALUMINA OXIDE VALVE BALL
TEFLON VALVE SEATS
KEL-F DIAPHRAGM

Solid Lapp Chemical Porcelain, combined with parts of alumina ceramic, teflon and Kel-F plastics, is used for the liquid end of this model of Lapp Pulsafeeder. All parts which can come in contact with liquid being pumped are non-metallic, chemically inert. Thus, positive-displacement metered pumping of "hard-to-handle" corrosive chemicals is made certain and permanently trouble-free.

NOTHING ELSE LIKE IT!

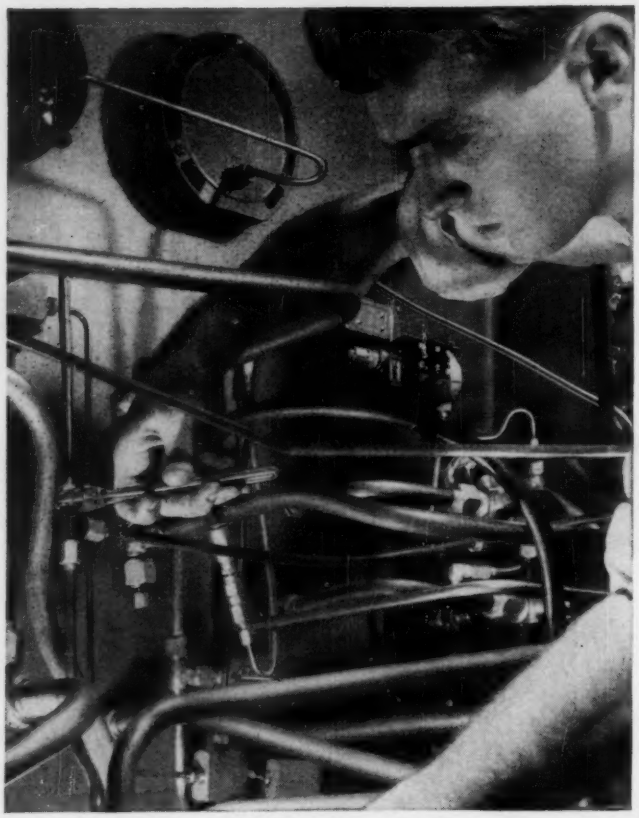
Lapp Pulsafeeder is the combination piston-diaphragm pump for controlled-volume pumping of fluids. Reciprocating piston action provides positive displacement. But the piston pumps only an hydraulic medium, working against a diaphragm. A floating, balanced partition, the diaphragm isolates chemical being pumped from working pump parts —eliminates need for stuffing box or running seal. Pumping speed is constant; variable flow results from variation in piston-stroke length—controlled by manual hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable.

WRITE FOR BULLETIN 440

with typical applications, flow charts, description and specifications of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Division, 379 Wilson Street, Le Roy, New York.

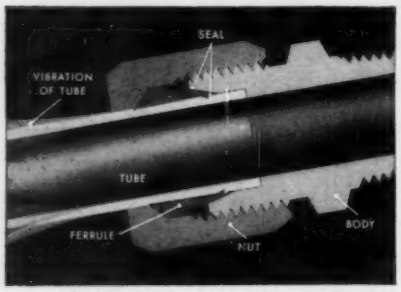
For more information circle **29** on inquiry card.

←——Circle **28** on inquiry card.

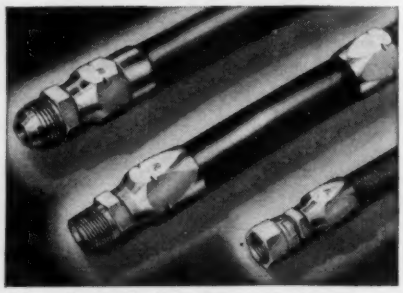


"Tube up and forget it" with leakproof Parker fittings

Triple-lok flare fittings are the easiest, fastest and safest way to tube up even in close quarters. They are absolutely leakproof even under the severest conditions of vibration, high pressures and temperatures. *Triple-lok* fittings meet J.I.C. and S.A.E. Standards plus specifications of the A.S.M.E. Code for Pressure Piping. Available for tubing outside diameters from ⅛ through 2 inches. More *Triple-lok* fittings are used on industrial machinery than any other fittings.



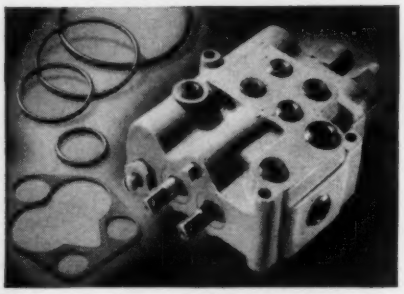
Ferulok flareless fittings, featuring the visible "bite", are especially for high-pressure, heavy-wall tubing. Cutaway shows why vibration won't break the seal.



New Hoze-lok fittings and hose assemblies (for medium and high-pressure hydraulic service) offer better performance, easier make-up, greater re-usability.

New Weld-lok fittings are machined from high-quality steel or stainless-steel bar stock and forgings. They are available for tubing ¼ through 2 inches, O.D.

New Intru-lok tube fittings can be quickly installed by anyone. Simply push tube in, then tighten nut. Designed for instrumentation lines of ¼ through ½ inch, O.D.



Other Parker products include new hydraulic control valves, check valves, accumulators and O-rings. Mail the coupon for the fitting catalogs you want.

TUBE AND HOSE FITTINGS DIVISION
Section 411-Q

The Parker Appliance Co.
17325 Euclid Avenue
Cleveland 12, Ohio

- ☐ Send Triple-lok & Ferulok Catalog No. 4300
- ☐ Hoze-lok Catalog No. 4400
- ☐ Weld-lok Catalog No. 4370
- ☐ Intru-lok Catalog No. 4320A1

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Company _____
Address _____
City _____ State _____

Parker

Hydraulic and fluid system components

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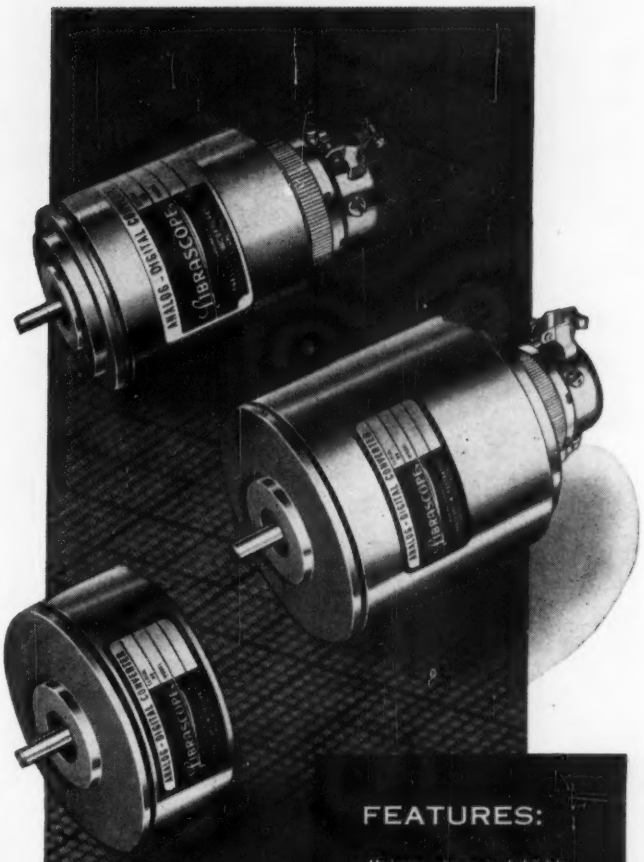
Flexibility in Application
Versatility in design...

packaged analog-digital converters

Shaft Position to Digital Converters features reliability, long life, non-ambiguity and speed makes these converters ideal for computers or data handling systems where serial read-out is preferred. Librascope converters transmit information at almost any rate desired up to 1 mc and in some cases above, and may be multiple time-shared, holding extra circuitry to a minimum. All units quickly adjustable, syncro-mounted. Available in Binary, Gray code or Binary decimal code as shown in chart below. Special units may be designed to your order.

Write for catalog information.



CODE	MODEL*	RESOLUTION PER INPUT SHAFT REV.	RESOLUTION OVER FULL RANGE	DIMENSIONS DIAMETER X LENGTH
BINARY	7 digit	128	1 part in 128	2" x 2 49/64"
	13 digit	128	1 part in 8192	2" x 3 19/32"
	17 digit	128	1 part in 131,072	2" x 4 13/16"
	19 digit	128	1 part in 524,288	2" x 4 13/16"
BINARY CODED DECIMAL	0-2000	200	1 part in 2000	3 1/16" x 4 27/32"
	0-3600	200	1 part in 3600	3 1/16" x 4 27/32"
	0-20,000	200	1 part in 20,000	3 1/16" x 4 27/32"
	0-36,000	200	1 part in 36,000	3 1/16" x 6 3/8"
GRAY	8	256	1 part in 256	3 1/16" x 1 11/16"

*SPECIAL UNITS AVAILABLE

Precision gearing
Shaft Speed: 120 rpm continuous
Operating temp: —55° C to +75° C
Shock and Vibration: up to 15 G, 5 to 500 cps.

Life Expectancy: Function of lead current. For 13 digit unit @ 2 ma. per brush, life approx. 5×10^9 breaks or makes at approx. 120 rpm.

FEATURES:

- Unique, staggered double brush pick-off system.
- Reads out serially into relays or single or multiple scan matrices.
- Analog-digital or digital-analog operation.
- May be time-shared.
- Syncro-mounted.
- Associated circuitry can be designed to fit your data-handling problems.

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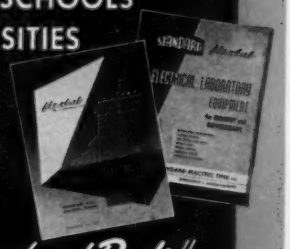
IN GOVERNMENT

IN VOCATIONAL and TECHNICAL SCHOOLS and UNIVERSITIES

Why not send for Flexlab Catalog #187 — "Laboratory Equipment for Industry and Government" . . . or for Flexlab Catalog #216 — "Laboratory Equipment for Vocational and Technical Schools."



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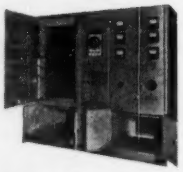
IN GOVERNMENT

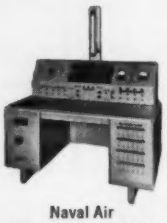
Naval Research Laboratory

Los Alamos Physics Laboratory

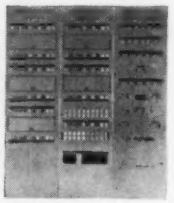


McClellan Air Force Base

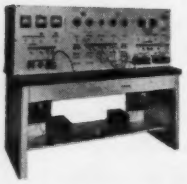
Aberdeen Proving Grounds



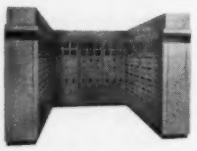
Naval Air Development Station



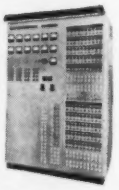
Frankford Arsenal



Pensacola Naval Air Station

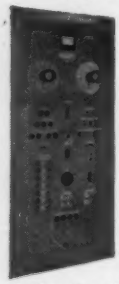


White Sands Proving Grounds

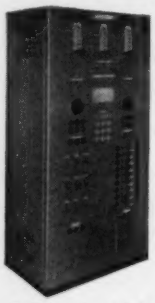


Naval Research Laboratory

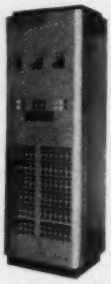
IN SCHOOLS and UNIVERSITIES



Bell Vocational School

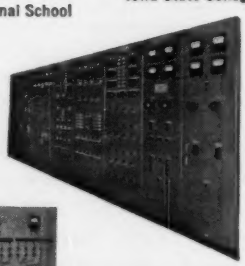


Bell Vocational School

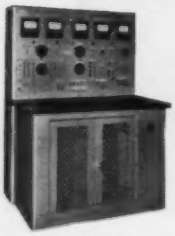


Iowa State College

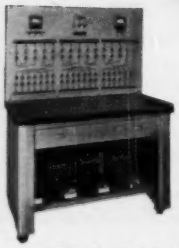
Princeton University



Bergen County Vocational School

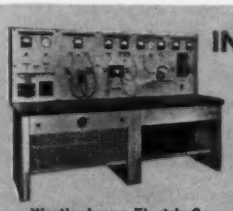


Technical School



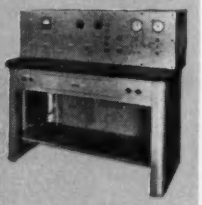
Bell Vocational School

IN INDUSTRY and RESEARCH

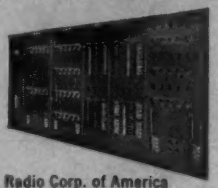


Westinghouse Electric Co.

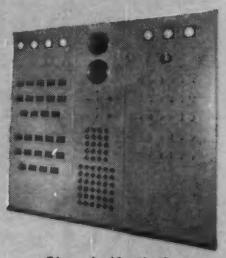
Monsanto Chemical Co.



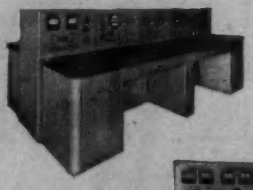
Ford Motor Co.



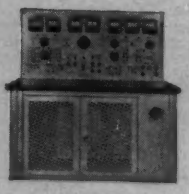
Radio Corp. of America



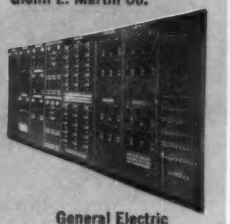
Glenn L. Martin Co.



Commonwealth Edison



Packard Motor Co.



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PRECISION TIMERS • CHRONO-TACHOMETERS • PIPELINE NETWORK ANALYZERS

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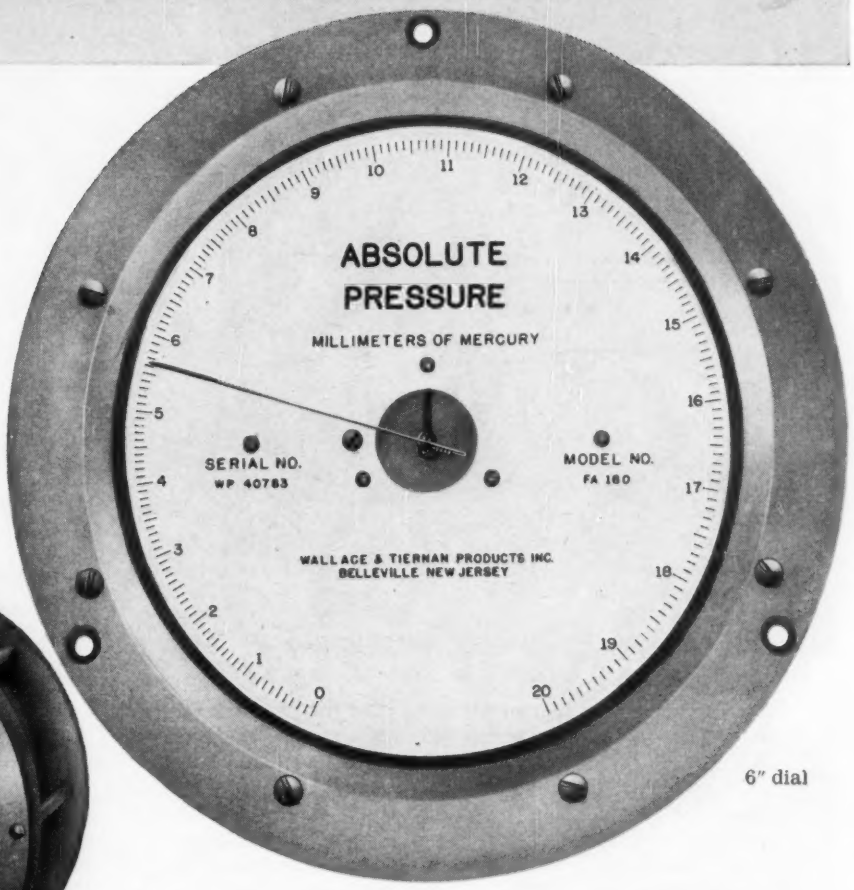
ABSOLUTE PRESSURE INDICATOR

. . . FOR DEEP VACUUM WORK

Measures *pressure*
directly from
ZERO ABSOLUTE
to atmospheric

. . . swiftly and precisely



6″ dial

2¾″ dial

Used as a pressure indicator in any system employing a vacuum.

- All readings are relative to ZERO ABSOLUTE.
- Dial *reads directly.*
- Accurate to 1 part in 300 over full scale.
- Sensitive to 1 part in 500 in *all* ranges.
- No auxiliary indicator or corrections for ambient pressure changes required.
- Protected against sudden pressure surges.
- Ranges:

0.1– 20mm Hg.	0–200mm Hg.
0 – 50mm Hg.	0–410mm Hg.
0 –100mm Hg.	390–800mm Hg.

- Dial Sizes: All ranges in either 2¾″ or 6″ dia.

TYPE FA-160

For additional information on W&T Absolute Pressure Indicators, write today for Publication No. TP-28-A.

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INCORPORATED
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A-102

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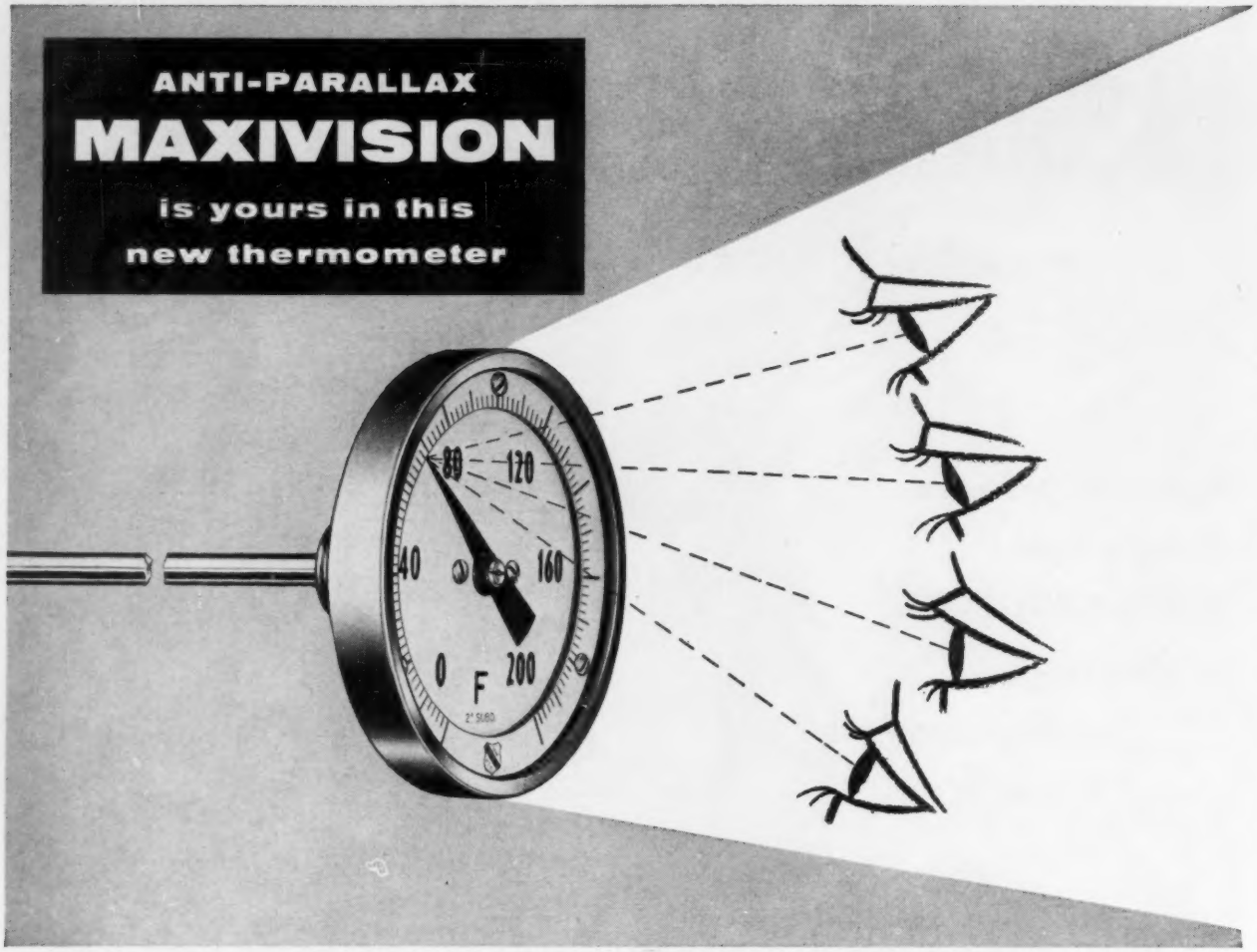
ANTI-PARALLAX

MAXIVISION

is yours in this new thermometer



Now you can read temperatures *right at the process* with the same ease, accuracy and economy as pressure readings. The Anti-Parallax Maxivision Dial on this new all stainless steel American Bi-Metal Thermometer assures these important advantages. The large, easy-to-read black figures and graduations are carried on a raised ring set close to the glass, with pointer at the same level. Parallax error is practically eliminated.

With this new thermometer in service, field operators can eliminate frequent trips to the control house to observe process changes. Indoors or outdoors, this fine, all stainless steel American instrument is truly climate-proof. Because the case is only 3" in diameter, the thermometer fits where space is limited. Ample clearance behind the case makes installation easy and fast with a small wrench. Read the specification highlights, then get full details about this new high-accuracy American Bi-Metal Thermometer.

PHONE your Industrial Supply Distributor for prompt attention to your needs. He is always ready to help keep your production going by making fast delivery from local stocks.

SPECIFICATIONS

New AMERICAN ALL-STAINLESS STEEL BI-METAL THERMOMETER with ANTI-PARALLAX MAXIVISION DIAL

Dial: Exclusive anti-parallax Maxivision dial, with scale approximately 6" long. Pointer set at same level as scale.

Climate-Proof Case: All stainless steel. 3" diameter. Threaded bezel. Selected clear, extra-heavy cover glass. Heat-resistant gaskets between glass and case seal the thermometer against rain, frost, sand, dust, fumes—climate-proof.

Temperature Ranges: From minus 80° to plus 1000° F. Accuracy within 1% of range.

Low-Mass Bi-Metal Coil: Welded to stem plug. Accurately centered in stem. Non-freezing, non-corrosive silicone fluid on coil dampens vibration, accelerates heat transfer, speeds response; does not gum, resists capillary action.

Pointer: Index type. Easily accessible from front of dial for positive adjustment over entire range. Pointer shaft guided by friction-free bearings.

Stem: 18-8 stainless steel, mirror polished. All joints welded. Resists corrosion. Provides strong, rigid and tight closure against process pressures. Lengths: 2½" to 24".

Connection: Fixed, ½" N. P. T.

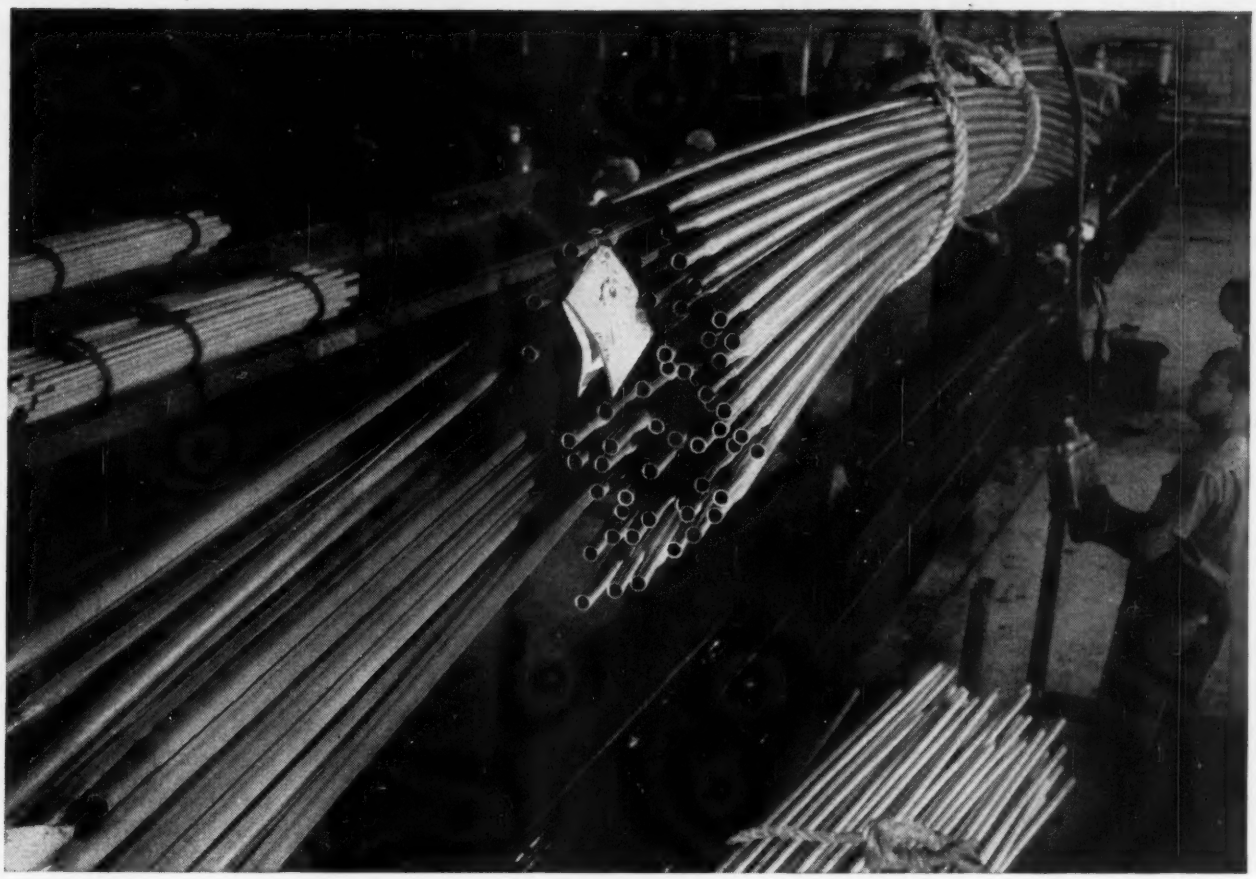
Separable Sockets: Available for use in closed systems or where measured medium is corrosive to the stainless steel stem. Fit over all standard stem lengths except 2½".

AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, *Stratford, Conn.* HANCOCK VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **34** on inquiry card.



Good News about Titanium!

SUPERIOR TITANIUM TUBING NOW AVAILABLE IN A WIDE RANGE OF SIZES, FORMS, TEMPERS

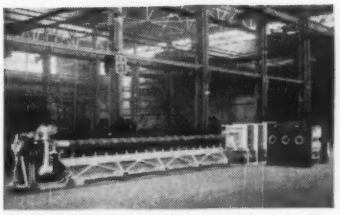
The big news about titanium these days is not its high strength to weight ratio; its formability; its corrosion, heat and electrical resistance. Engineers know all this. What they want to know is *when*. The answer is *right now*, as far as tubing is concerned.

Although everything is special as far as the production of titanium tubing is concerned—more grinding operations are required, special lubricants have to be employed, drawing schedules have to be much lighter, annealing must be done in special furnaces, special pickling solutions are demanded—the end result is always a standard tubing obtainable from Superior distributors coast to coast. Sizes range in O.D. from .012″ up to 1.50″, in wall thickness from .002″ to .187″, and in lengths up to 24 feet. Tempers—fully annealed, half hard and full hard. Forms—Seamless and Weldrawn®.

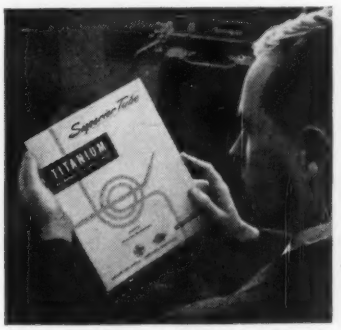
Applications are increasing rapidly. They now range from use in the atomic energy programs—to low stress aircraft structural parts—to pneumatic, hydraulic, refrigeration lines—to processing lines in the chemical industry.

Write now for your free copy of Bulletin 43—it contains complete technical and ordering information—and for the name of the Superior distributor nearest you. SUPERIOR TUBE COMPANY, 1968 Germantown Ave., Norristown, Pa. *On the West Coast:* Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif.

Round and shaped tubing available in Carbon, Alloy and Stainless Steels; Nickel and Nickel Alloys; Beryllium Copper; Titanium; Zirconium



Titanium is reactive, must be heat treated without atmospheric contamination. This vacuum annealing furnace handles material 24 feet in length, operates at temperatures up to 1850°F. is automatically controlled.



All you need to know about titanium tubing is contained in this newly revised 8-page booklet—Bulletin 43. Contains processing information, properties, advantages and end uses, describes sizes, forms and tempers available.

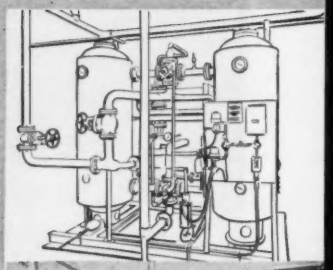
Superior Tube

The big name in small tubing

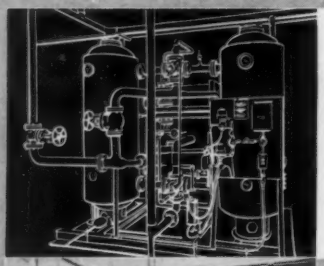
All analyses .010″ to ⅝″ O.D. Certain analyses in light walls up to 2½″ O.D.

For more information circle **35** on inquiry card.

10 REASONS WHY THE PRITCHARD HYDRYER IS THE ANSWER FOR INSTRUMENT AIR DRYING

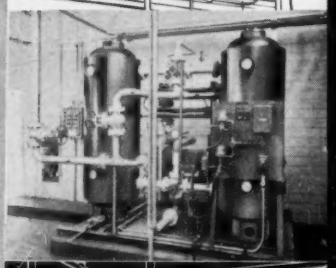


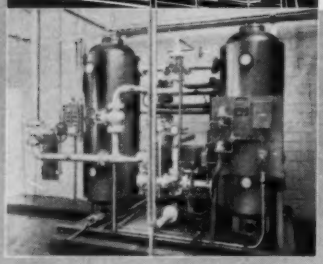
1. NO WASTE. 100% of all gas entering the HYDRYER is dried without loss.



2. FULL LINE PRESSURE REACTIVATION. Pressuring and de-pressuring of adsorbers between cycles is eliminated.

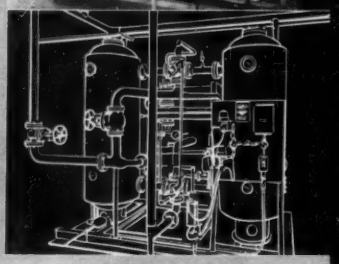
3. PURGING ELIMINATED. The Type A HYDRYER uses the inlet main gas stream for reactivation, not an external stream of atmospheric air or other gas.





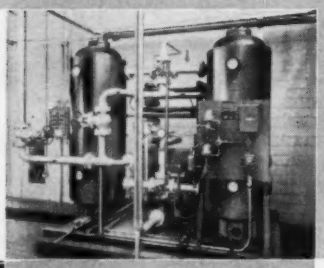
4. LONGER ADSORBENT LIFE. Dusting and breakage of particles is reduced because there is no movement of adsorbent due to pressure changes or high velocities.

5. REACTIVATION GAS IS PREHEATED. This assures complete heat transfer during the heating period for uniform reactivation of the adsorbent.



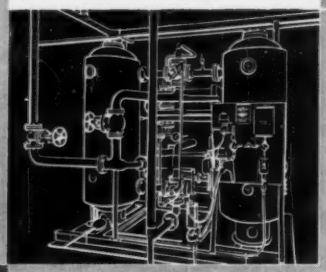
6. NO MOVING PARTS. No operating or maintenance costs on blowers, motors, fans, rotating beds . . . because there are none.

7. SIMPLIFIED OPERATIONS. The process is greatly simplified, requires minimum of operations. Important, when you have inexperienced operators.

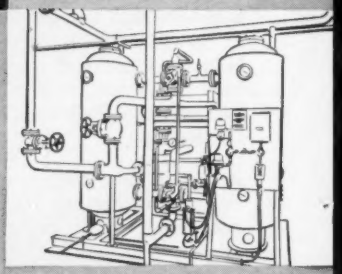


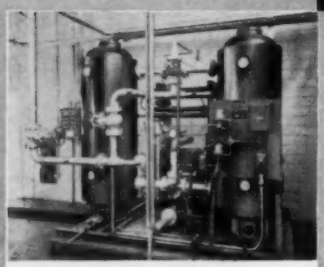
8. REDUCED EQUIPMENT AND LINE SIZES. Equipment and line sizes are small compared to those required for reactivation at atmospheric or lower pressures.

9. SAFETY FACTORS MINIMIZE HUMAN ERROR. No equipment can be damaged by opening the wrong valve.



10. VISUAL OBSERVATION and check of the moisture adsorbed from the gas stream is possible on each cycle.





HYDRYER ON DUTY, drying instrument air at the Farmers Union Exchange Refinery, Laurel, Montana. It dries 400 SCF/M of air at 60 psig and 80-95°F. saturated. Outlet gas dew point is —40°F.

SEND FOR BULLETIN

You can learn about the many ways HYDRYERS may be used to dry instrument air from this Pritchard bulletin, No. 16.0.181. Send for your complimentary copy today on your company letterhead.

INDUSTRY'S PARTNER FOR PROGRESS

COOLING TOWERS
AIR COOLED HEAT EXCHANGERS
GAS & AIR TREATING EQUIPMENT

REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

J.F. Pritchard & Co.
OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 448, 4525 Roanoke Parkway, Kansas City 12, Mo.

Critical inspection welcomed...

Here's the "workhorse" of the relay industry. Class "A" is a low-cost rugged relay that stands up under critical inspection . . . even after 25 to 50 million operations!

permanently attached contact points

Contact points are resistance-welded—permanently anchored to the spring for the life of the relay. Continual quality checks on the manufacture of the springs assure lifetime service.

exclusive backstop design

Backstop is specially formed to prevent armature freezing and to increase life. A "heavy-duty" armature bearing can be supplied for heavy spring loads or constant high-speed operations; its oversized, hard-metal pin turns in *precision*, long-wearing bearings.

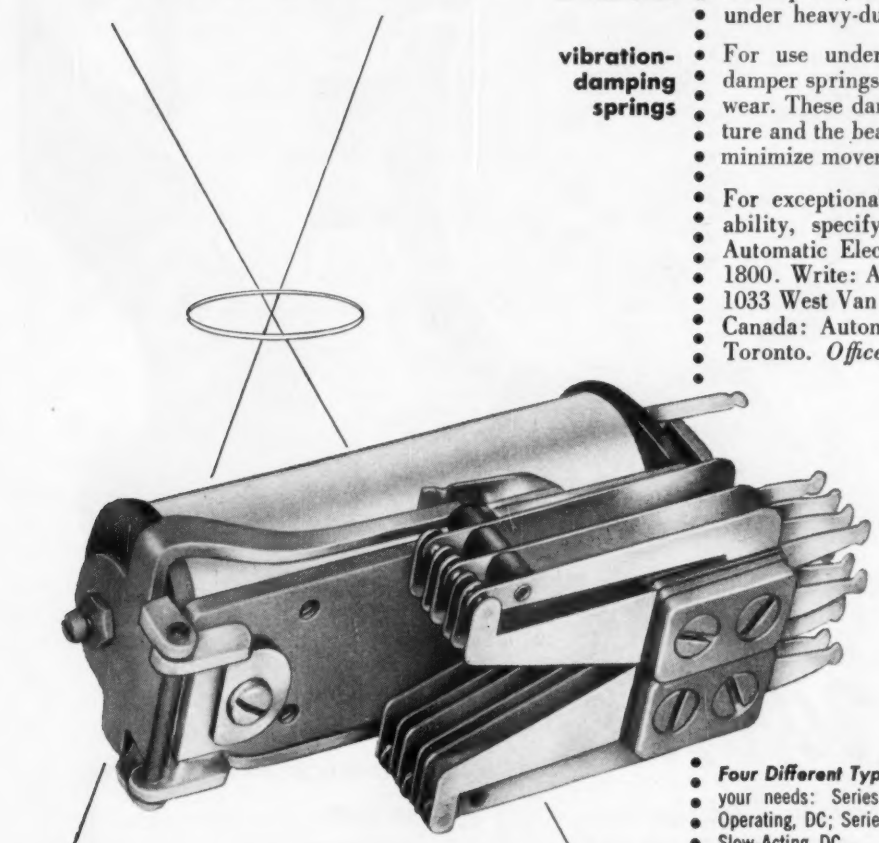
both types of armatures

A choice of "long" or "short" levers gives you the lever ratio required for normal operating and release speeds, or for a residual gap that doesn't vary under heavy-duty conditions.

vibration-damping springs

For use under conditions of extreme vibration, damper springs can be supplied to prevent excessive wear. These damper springs bear against the armature and the bearing pin with considerable pressure, minimize movement due to external forces.

For exceptional performance, sensitivity and durability, specify this outstanding member of the Automatic Electric relay family. Ask for Circular 1800. Write: Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*



Automatic Electric Class "A" Relay

class "A" specifications

Four Different Types of Class "A" Relays are available to meet your needs: Series AQA—Quick-Acting, DC; Series ASO—Slow-Operating, DC; Series ASR—Slow-Releasing, DC; and Series ASA—Slow-Acting, DC.

Contacts—Normally single, but can be supplied with twin contacts. Load carrying capacity, 150 watts (maximum 3 amps., non-inductive).

Contact Spring Capacity—Can be supplied with single or double pile-ups. Series AQA and ASO, 13 springs per pile-up; Series ASR and ASA, 6 springs per pile-up. (More contacts can be accommodated at a sacrifice of operating speed and release time delay.)

Dimensions—Overall length, 4". Width, single pile-up—1¼", double pile-up—1 7/16". Height (depending upon the number of springs), Series AQA and ASO, 1⅝"-2 3/16"; Series ASR and ASA, 1⅝"-2".

For more detailed information, ask for Circular 1800.

RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

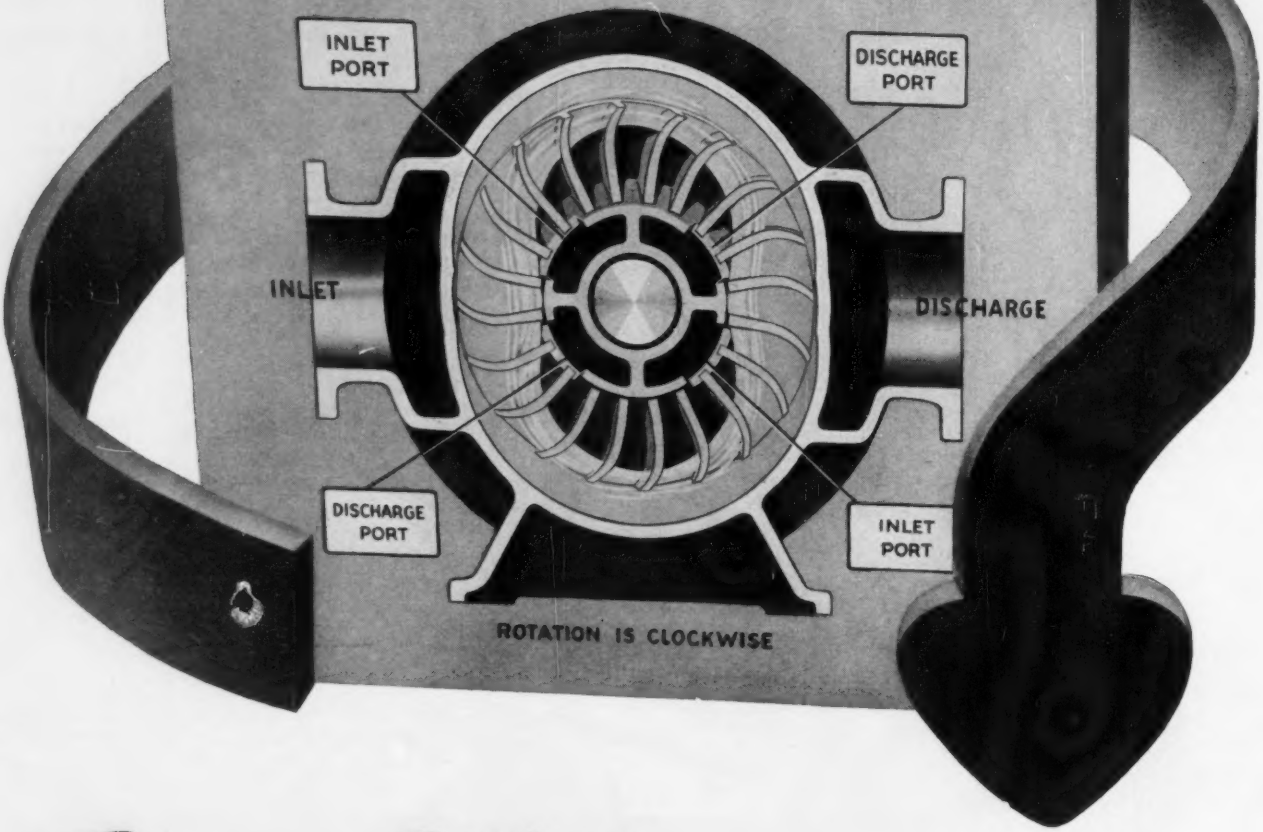
AUTOMATIC ELECTRIC

CHICAGO

For more information circle **37** on inquiry card.

←Circle **36** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



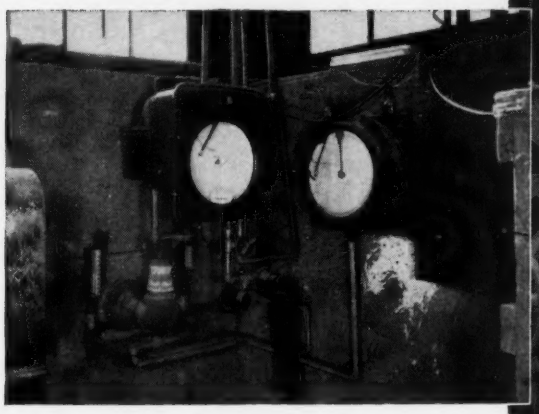
Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

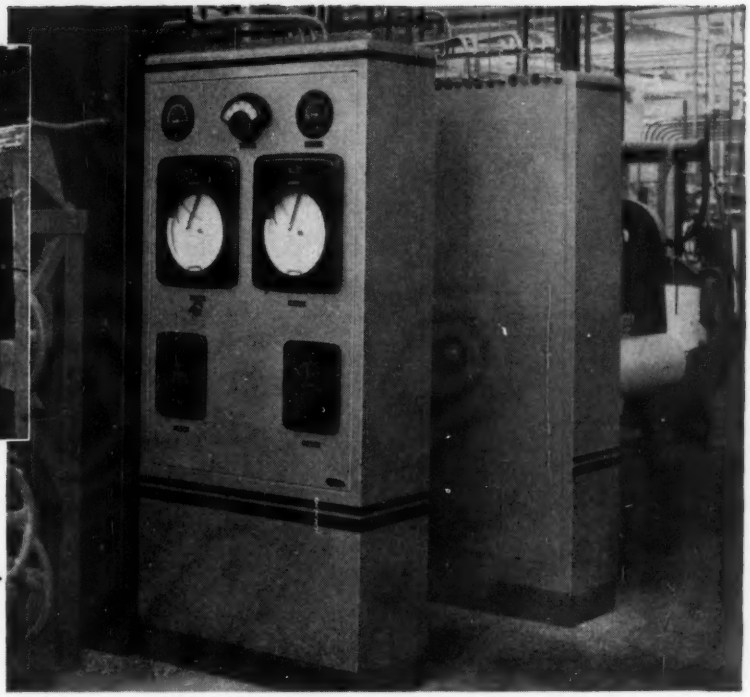
®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.



This is part of an old-fashioned installation which lacks the convenience and efficiency of modern instrumentation.

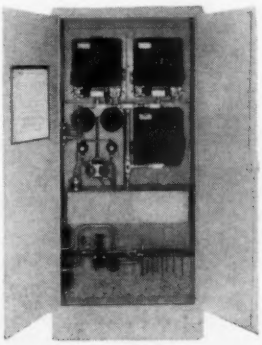


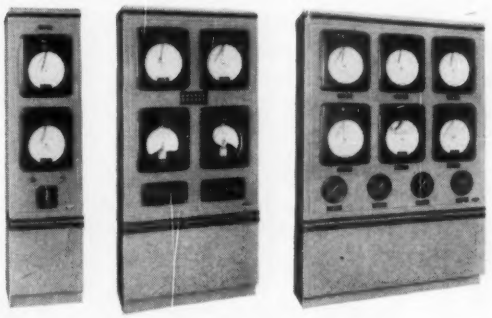
Compare this centralized Foxboro Cabinet installation of similar instrumentation, which saves time for the operator, makes his work more efficient, and gives maximum protection to the precision instruments required for his process.

See what a difference FOXBORO cabinet-mounting can make!

These photos show at a glance how much more efficient and attractive your instrument installation can be if it's integrated and centralized in a Foxboro Cabinet. Not only are the instruments protected from dust and process "atmospheres", but they're conveniently grouped together for more efficient use and easier maintenance. Those "endless steps" of the operator are a thing of the past!

Foxboro will supply a cabinet (or cabinets) to house and protect any number of existing instruments and related devices. Or your order for new instruments can be shipped to you already mounted in cabinets, completely piped and wired, needing only simple power and process connections to be put into operation. Write for illustrated and informative Bulletin 413.





Foxboro Cabinets are available in three standard sizes for 2, 4, or 6 conventional-size instruments (or equivalent). For mounting more than 6 instruments, Foxboro Sectional Cabinets (with open ends) are used . . . bolted together to form desired length. End sections have one closed side to form dust-tight enclosure. Exclusive insert-type panel construction permits easy conversion when process changes so require.

THE FOXBORO COMPANY, 463 NEPONSET AVENUE, FOXBORO, MASS., U. S. A.

FOXBORO REG U S PAT OFF PROCESS CONTROL CABINETS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

For more information circle **38** on inquiry card.

THE 1956 INSTRUMENTS and AUTOMATION CATALOG and INDEX

—the industry's ONLY directory—

Publication date, July 1955

CIRCULATION: The *Index* will be sent to 20,000 users of instruments and devices for measurement, inspection, testing and control. These are the 20,000 most important men who buy, install and maintain instrument and control devices.

COMPLETE HORIZONTAL COVERAGE of the men who buy and specify instruments and controls in every major instrument-using company. The *Index* reaches the largest number of potential instrument buyers at lowest cost.

PRODUCTS ADVERTISED are scientific and industrial instruments; automatic electrical, mechanical, hydraulic, electronic and pneumatic controls; electric and electronic instruments; testing machines and devices; inspection devices and gages; control valves; relays; timers; laboratory and glass apparatus; etc.

CLOSING DATES: Copy to prepare, all details must be in our Pittsburgh Office not later than April 1st. Layout and copy will be sent to the advertiser for his OK and also final proofs.

Copy to set	May 20th
If no proof required	May 25th
Complete plates	June 1st
Inserts	June 15th

Advertisers' Names **Boldface** in Descriptive Directory: Advertisers in the *Index* will have their names in boldface type in the Descriptive Directory Section and reference will also be made to the page number (s) on which their advertisement (s) appear. This gives to the individual seeking information the two vitally important elements of the *Index*—1. Where he can buy it, and 2. Technical data, when he turns to the page to which he is referred.

RATES and Mechanical Requirements: Advertisers will be entitled to the rate earned in the 12 regular issues of *Instruments* and *Automation* or to the rate they earn in the *Index*, whichever is most advantageous. Space used in the *Index* will not help earn a rate in the regular issues of *Instruments* and *Automation*. But the rate earned in the regular issues will determine the rate for the *Index*.

INDEX RATES ARE THE SAME AS REGULAR *INSTRUMENTS & AUTOMATION* PER PAGE RATES

1 Page	$360.00	6 Pages	$314.00
2 Pages	354.00	8 Pages	302.00
3 Pages	344.00	9 Pages	297.00
4 Pages	338.00	12 Pages	275.00

All AAAA Standard Colors: Red, blue, yellow, orange, green, $100.00 per page for any one color. Matched colors $120.00 per page for any one color. Rates for metallic inks quoted on request. Bleed Pages: per page, extra $75.00

Rates for Complete Inserts:

2 Pages (backed up)	$ 530.00
4 Pages (backed up)	1150.00
8 Pages (backed up)	2050.00

Mechanical Requirements

	Width	Depth	Width	Depth
1 Page	7	10	———	———
⅔ Page	4½	10	———	———
½ Page	3⅓	10	7	4⅝
⅓ Page	2⅛	10	4½	4⅝
¼ Page	3⅓	4⅝	———	———
⅛ Page	2⅛	4⅝	———	———

Halftones should be 110 screen.
Page trim size—8¼" wide x 11¼" deep
Bleed size—8⅜" wide x 11½" deep
Actual type measurement inside border.

INSERTS (Letterpress): Rates for complete inserts apply on inserts which are ready for binding when received. Before making plates or ordering printing please check with the Pittsburgh Office as to number of pages, quantity required, trim size. Maximum acceptable weight 100 lb. coated, 25 by 38 inch basis, or equivalent.

REPRINTS: Regular run of book stock will be used unless special stock is supplied by the advertiser. For reprint costs write Pittsburgh Office.

INSTRUMENTS PUBLISHING COMPANY

845 Ridge Ave., Pittsburgh 12, Pa. **Telephone: Fairfax 1-0161**

See Page 327 For District Offices and Managers

For more information circle **39** on inquiry card.

Safety X5 Series
Only $3^{27}/_{32}$" high

VERSATILE AND VIGILANT!

Low-Cost, Explosion-Proof SKINNER Solenoid Valve Underwriter Approved for Gas Vapors, Carbon and Grain Dust Applications

For hazardous locations, specify the Skinner Safety X5 Series Valve. It's Underwriter Approved for Class I, Group D, and Class II, Groups F and G. And no other explosion-proof valve has the simplicity and flexibility of the X5 design!

Skinner Safety X5 Series valves are skillfully engineered to give trouble-free operation through millions of cycles. They are direct acting, spring loaded, *leakproof* . . . and give positive performance in any position.

Valves of this series have stainless steel internal parts and are offered in five basic types: two- and three-way normally open; normally closed; and directional control. They are available with a broad selection of electrical outlets, port locations and sizes, flow adjustments and coil types.

Media — Air, gases, vacuum, oil, water and many semi-corrosive media.

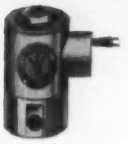
Pressure Rating — 0-1000 p.s.i.

Construction — Leakproof sealing, bubble-tight shut-off at all ports; packless, frictionless construction; precision-machined stainless steel internal parts; electronically-controlled, pressure-tested welds.

Simplified Servicing — can be disassembled and repaired without removal from the line.

Specifications — *Duty Cycle* — continuous or intermittent.
Orifice Diameters — $^{3}/_{64}$" to $^{1}/_{4}$".
Pipe Size — $^{1}/_{8}$" or $^{1}/_{4}$" NPT.
Voltage — all common AC and DC voltages.
Power Consumption — 10 watts.

Do you have a valve problem? Ask us for the services of a specially trained Skinner resident engineer — he'll tackle your problem immediately.

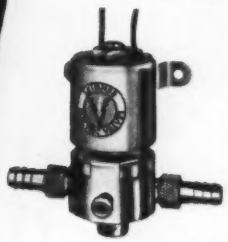


GENERAL SERVICE & VACUUM
V5 Series
2- & 3-Way
0-1000 p.s.i.

MINIATURE CUT-OFF
V2 Series
2-Way
0-250 p.s.i.

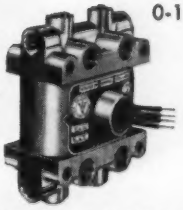
QUICK EXHAUST
(extra fast cylinder return)
V5-3 Series
3-Way
0-150 p.s.i.

HI-PRESSURE HYDRAULIC
V10 Series
2- & 3-Way
0-1000 p.s.i.

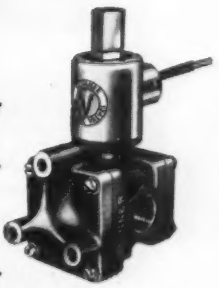


SANITARY
V4 Series
2-Way
0-20 p.s.i.

EXPLOSION-PROOF
X5 Series
2- & 3-Way
0-1000 p.s.i.



ALL-PURPOSE FOUR-WAY
V9 Series
4-Way 0-150 p.s.i.



HI-FLOW INDUSTRIAL
M Series
2- & 3-Way 5-150 p.s.i.

World-Wide Representation — Immediate Delivery on Standard Valves

SKINNER SOLENOID VALVES

SKINNER ELECTRIC VALVE DIV.
The Skinner Chuck Company
116 Edgewood Avenue, New Britain, Connecticut
Please send us your bulletins on the following Skinner valves:

.....
.....

Please have a Skinner representative call on (date)

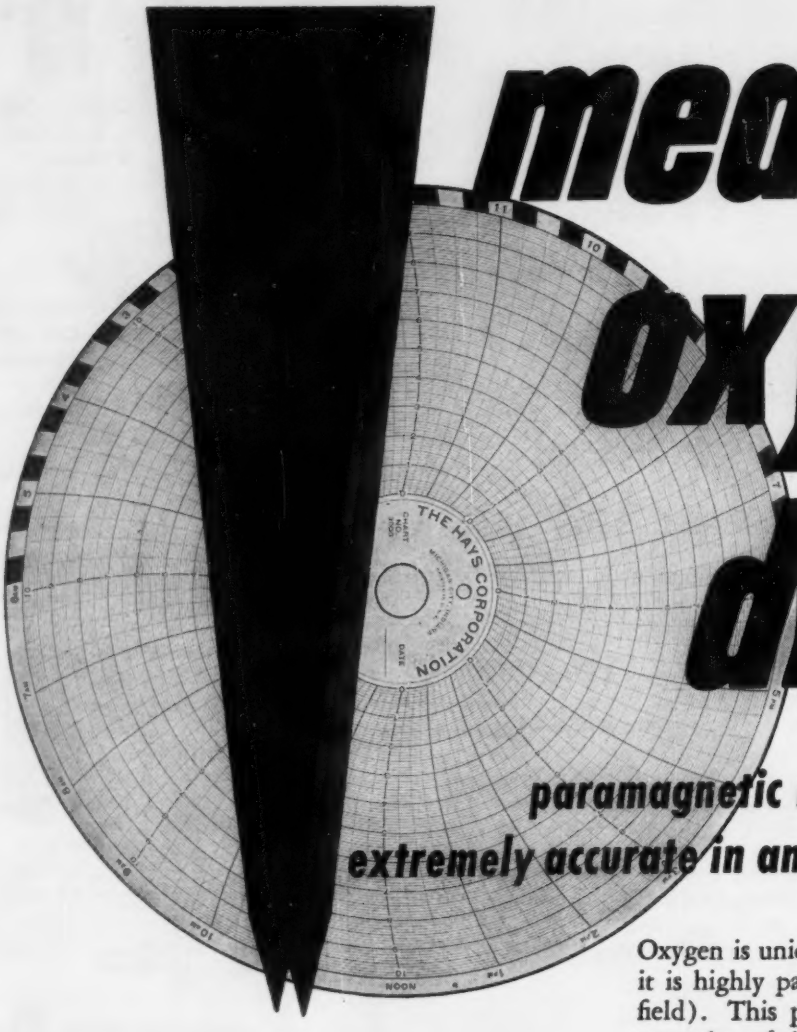
.....

Name.....
Company.....
Street.....
City.....*Zone*....*State*.....

® THE CREST OF QUALITY

For more information circle **40** on inquiry card.

measure oxygen direct



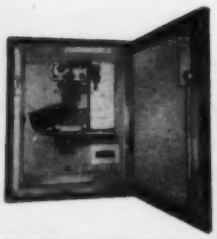
paramagnetic method of measurement extremely accurate in analyzing industrial gases

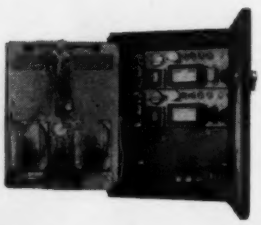
Oxygen is unique among other common gases in that it is highly paramagnetic (attracted into a magnetic field). This property of oxygen is the basis of the operation of the Hays Magno-Therm Analyzer in the analysis of industrial gases.

application

Hundreds of companies are using the Hays Magno-Therm O_2 Analyzer and Recorder in applications from revivification of SO_2 removers in manufactured gas industry and regeneration of catalysts in oil refineries to mixing air with propane to get substitute fuel. Boiler plants use it as a combustion guide because it is the only means of getting an undistorted picture of excess air.

Write today for bulletin 52-829-56 and get complete details.





ANALYZER	RECORDER
Highly sensitive to changes in oxygen content.	Self-balancing bridge circuit assures accurate, permanent calibration.
Rapid response to changes in oxygen content.	Electronic amplifier has no moving parts. High sensitivity. Rugged.
No liquid or gaseous fuel required to be added to gas sample.	Immediate response—analyzer is continuously connected to recording pen drive motor.
No chemicals required.	As many as four analyses can be recorded on the same chart.
High accuracy maintained.	Range can be changed easily in the field.
Not affected by wide variation in rate of flow of gas sample.	Isolating transformer for each amplifier removes line interference from bridge circuit.
Rugged construction. No delicate or moving parts.	Extra slide wire available for control, remote indication—for recorder or contacts for alarm circuit.
Easily installed — no special fittings required.	

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

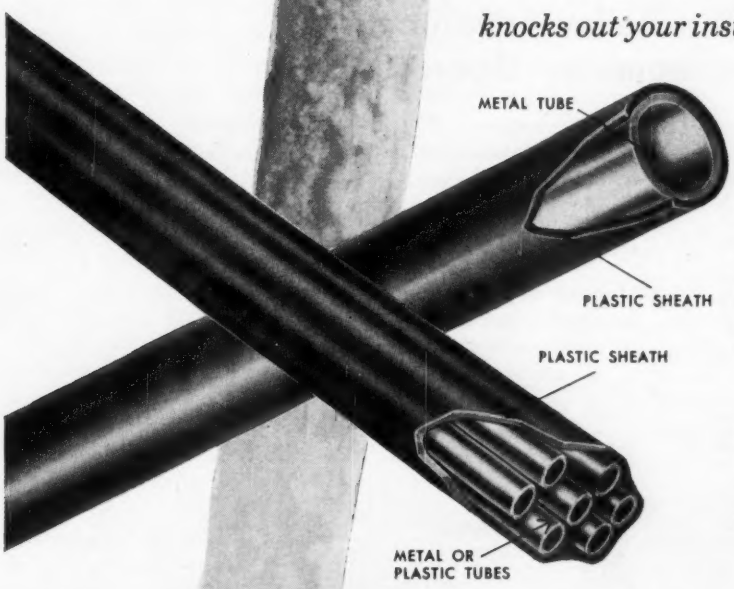
THE hays CORPORATION

Michigan City 8, Indiana

For more information circle 41 on inquiry card.

DEKORON INSTRUMENT TUBING

knocks out your instrument line corrosion problems



DEKORON single-line tubing. Samuel Moore & Co. will coat your copper, aluminum or steel tubing by the Dekoron extrusion process, or will supply coated tubing. Straight lengths to 20 ft., coils to 1000 ft.

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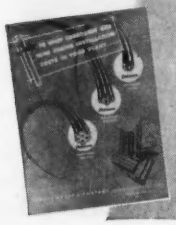

Send for free copy of Bulletin L-6506 "3 Ways to Whip Corrosion and High Tubing Installation Costs in Your Plant."

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PYROTRON
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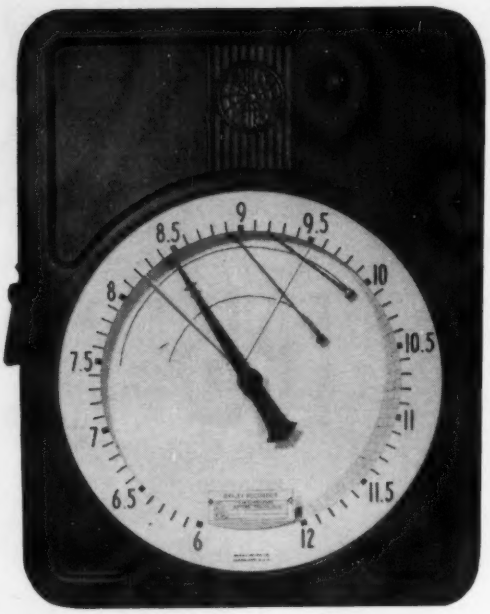

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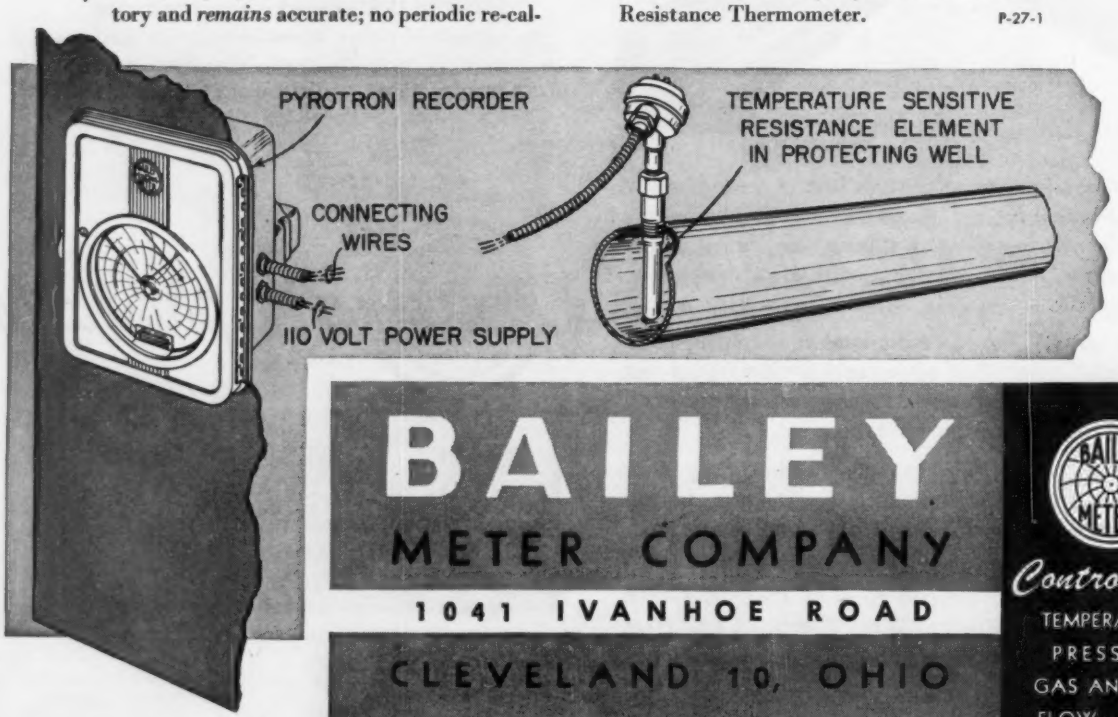
✓ For complete information, write for bulletin 230-C on the Bailey Pyrotron Electronic Resistance Thermometer. P-27-1



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Editorial...

INSTRUMENTS and AUTOMATION

THE NEW TECHNOLOGY

WALTER P. REUTHER, *President, International Union, UAW-CIO*

The first industrial revolution had a tragic impact upon the lives of many people. Ruthlessly workers were displaced by the first power-driven machines. They were turned into the streets to wander about homeless and hungry. In desperation the workers struck back at the calloused indifference and social irresponsibilities of the owners of the primitive early power-driven machines. In France, in Germany, and most notably in England, the Luddites, inspired by mythical King Lud, burned factories, wrecked machinery, rioted, and inspired a guerilla war that lasted for almost 20 years.

Out of these early struggles came our modern labor movement.

Now we enter the second phase of the industrial revolution, and the impact of automation—for good or for evil—is magnified a thousandfold. The need for enlightened social policies becomes imperative. Automation must be met sanely and constructively so that the miracle of mass production—and the ever greater economic abundance made possible by automation—can find expression in the lives of people through improved economic security.

Sensibly, rationally, scientifically we intend to harness this radical new force in our lives using its potential to produce an era in which well being, justice, and peace will be the universal possession of all mankind.

Historically the problems of mankind have been set in conflict between people, groups, and nations each engaged in a struggle to divide up economic scarcity. We have had a world divided between the "haves" and the "have-nots"—those who were fed and those who were starving. Now, science and technology have at last given us the tools of economic abundance, and we no longer need to struggle to divide up scarcity.

Economic abundance is now within our grasp if we but have the good sense to use our resources and our technology, fully and effectively, within a framework of economic policies that are morally right and socially responsible.

People and nations have demonstrated the capacity to achieve total dedication in periods of great international conflict. Motivated by common fears and hatreds in times of war, people and nations have made their greatest sacrifices and achieved the fullest measure of common purpose. Now, automation and the new technology, together with the promise of peacetime use of atomic energy, afford us the opportunity to give positive expression to our common hopes, common aspirations and common faith. These new tools of abundance provide us as free people with the opportunity to achieve total dedication in the common task of building a better tomorrow in a world in which people and nations can live at peace, free in spirit, free from tyranny, and free from the pangs of hunger.

The UAW-CIO and its one and one-half million members welcome automation, technological progress, and the promise of the peacetime use of the power of the atom. We offer our cooperation to men and women of good will in all walks of life in a common search for policies and programs within the structure of our free society that will insure that greater technological progress will result in greater human progress. It is in this spirit that we submit this report on automation and its relationship to the guaranteed annual wage for your consideration.

We in the UAW-CIO believe that we can solve the problems of UAW-CIO members as wage earners only as we work with other people in our free society in the common effort to find answers to the problems of all the people in our country—and ultimately in the world, for only as we learn to work with people everywhere in finding answers to the problems of the world community can we find answers to our own. As citizens of the atomic age we have the tools of abundance at our disposal. We are confident that the free people of America, in cooperation with free men everywhere, will demonstrate the good sense and the courage to use the tools of abundance for constructive and moral purposes.

We trust that this first UAW-CIO report on automation will contribute to a better understanding of the problem, the challenge, and the opportunity. This report on the problems of automation was prepared by a special study committee of the UAW-CIO. It was adopted by unanimous action of the UAW-CIO International Economic and Collective Bargaining Conference, composed of delegates representing one and one-half million workers throughout the United States and Canada.

The significance of this report is not in its prose or in its brilliance, but like other Union documents its significance lies in the fact that it demonstrates the ability of people to deal with their problems thoughtfully and rationally through committees, conferences, and congresses —in this instance in an effort to find the answers by which the second phase of the industrial revolution can be harnessed to peaceful and constructive purposes. We in the UAW-CIO are confident that we will not have to fight the new machines and devices. Rather, we will use them to bring health and happiness, security and leisure, and peace and freedom to mankind everywhere.

Introduction to a UAW-CIO report on Automation—see next page.

Editorial—

LABOR AND AUTOMATION

MUCH has been written about labor's stand on automation, most of which has given the impression that labor is taking a stand against introduction of automatic control techniques in industry, or that organized labor is demanding a Guaranteed Annual Wage as the price for permitting technological development to occur.

The automobile industry is the one in which automation techniques made great impact in 1954; it is the industry which invented the word automation. The International Union, United Automobile, Aircraft, and Agricultural Workers of America (UAW-CIO) is the union most affected by the developments in the automotive industry; it is the union asking for a Guaranteed Annual Wage in its forthcoming contract negotiations. Hence it was to the UAW-CIO that your editor directed the question: "Is the UAW-CIO demanding a Guaranteed Annual Wage in return for cooperation with automation developments"?

The answer to us from the UAW-CIO Automation Committee is as follows:

> "It is *not true* that the UAW-CIO is asking for a 'Guaranteed Annual Wage' because of the impact of automation. The demand for the annual wage predates the coining of the word 'automation.' The demand is based on the historic insecurity of the factory worker. Prior to and during the war CIO unions demanded guaranteed annual wages. The WLB (War Labor Board) postponed action on these union demands and the full-employment environment of the war temporarily abated the pressure for annual wages. But even so, as can be seen in the famous Lattimer report ('Guaranteed Wages, A Report to the President by the Advisory Board,' Office of War Mobilization and Reconversion, Office of Temporary Controls, Washington, 1947) this demand was not abandoned, just postponed.
>
> "The Guaranteed Annual Wage is but one point in a complete program aimed at full employment, high purchasing power, and an expanding economy. This program is presented in a pamphlet 'Full Employment—Key to Abundance, Progress & Peace,' which emphasizes that the Guaranteed Annual Wage is but one point in this program, and that it is needed not because of automation, but because purchasing power must be maintained high at all times if the economy is to continue to expand."

This communication emphasizes that the Guaranteed Annual Wage is being demanded for over-all economic reasons in which automation is but one added factor. Hence the Guaranteed Annual Wage should be discussed at all levels on the basis of whether or not it is good for the economy, not whether it is made necessary by automation.

This is not to imply that labor is not carefully watching all developments in automation. A resolution adopted by the 14th Constitutional Convention of the UAW-CIO, held in Atlantic City, March 22-27, 1953 was as follows:

> RESOLVED: That this 14th Convention of the UAW-CIO instructs the officers and International Executive Board to undertake a study of new technological developments on the industries within the our Union's jurisdiction and their implications for the purpose of developing appropriate policies.

This resolution led to a report called "Automation"—a Report to the UAW-CIO Economic and Collective Bargaining Conference, held in Detroit, Michigan, Nov. 12-13, 1954 (Publication 331 of the UAW-CIO Education Department, Solidarity House, Detroit 14, Mich., 25 cents).

This report contains an introduction by Walter P. Reuther, President, UAW-CIO, which we bring you as a guest editorial in this issue.

The theme of the *Automation Report* is that "if automation is irresponsibly introduced . . . it will bring unemployment (page 10) . . . The radical productivity increase which will accompany automation makes it necessary to intensify the fight for an economy based on full production and full employment . . . The establishment of the guaranteed annual wage becomes imperative for workers in the face of these new and revolutionary technological changes (page 11)".

These statements should not be used to infer that labor will oppose automation unless the Guaranteed Annual Wage is granted. Labor is saying that automation is inevitable, and, if used properly, desirable; and that the Guaranteed Annual Wage is necessary to maintain purchasing power. Industry can disprove this premise (if it is not true) by maintaining a high-employment economy —or it can demonstrate that it cannot afford the Guaranteed Annual Wage. And all this will be done in the American way, through committees and conferences of thoughtful and rational men.

We who are working in the field of automation, whose daily work implies replacement of manual efforts by automatic techniques, should recognize the validity of the premise that purchasing power must keep pace with the productivity increases inherent in an automated society. The efforts of organized labor to maintain high purchasing power are justifiable, and little good will come of preaching that there is nothing to fear while unemployment actually exists. Despite the fact that we know that the causes of the unemployment are NOT due to automation, we are in the position of being highly vulnerable scapegoats. Hence it is in our own best interests to examine carefully all plans presented for maintaining high employment and high purchasing power.

We do not indorse the Guaranteed Annual Wage. We do not know if American industry can afford such large commitments—or, indeed, if they can afford *not* to make the annual commitment inferred. But we recognize labor's right to offer such plans—and our responsibility to study them carefully. The pamphlets referred to in this editorial can be obtained from the UAW-CIO, Solidarity House, Detroit 14, Mich.

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For more information circle **44** on inquiry card.

New Instruments...

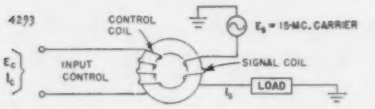
For further information use the postage-free order card on page 487

INSTRUMENTS and AUTOMATION

COUNTING, COMPUTING

Ferroceramic-magnetic Computer Elements

New "Magnistors" are an entirely new type of saturable reactor: essentially ferroceramic-material cores with magnetic windings; have exceptional operating frequency range (d.c. to 30 Mc.); are said to combine advantages of transistors and magnetic-core devices. Two basic types: (1) "Transient," simplest form having one signal coil and one control coil; units control from microwatts to tens of watts; another form has "inhibit" windings which can nullify control coil. (2) "Permanent" type has one signal winding in load circuit and two control windings—"set" and "reset," is a two-state or "memory" device that remains "set" or "reset" even when power is off—a static storage device with a non-destructive readout, capable of handling watts. "Magnistors" can be used to gate, switch, amplify, count; also to form logical arrays for computing functions; are available as individual components, amplifiers, gates, switches and flip-flops; will be available in complete switching matrices and other data-handling assemblies.—*Potter Instrument Co., 115 Cutter Mill Rd., Great Neck, N. Y.*



For more information circle **201** on inquiry card.

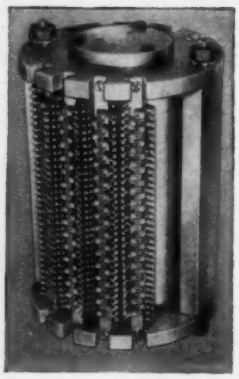
Computer Tubes

Two new tubes designed especially for computer applications, "Types GL-5915-A and GL-6211," join previously-announced "GL-5844, GL-5965 and GL-6463" in G-E computer line. "GL-5915-A" is a dual-control heptode, for use primarily as a coincidence-gating tube. Electrically and physically, it may be used as a replacement for "5915." "GL-6211" is a nine-pin medium-mu twin triode for binary-counter or amplifier applications. In electrical characteristics essentially equivalent to "GL-5844." Both feature high perveance and low heater-power requirements, and are life tested under cutoff conditions.—*General Electric Tube Dep't, Schenectady 5, N. Y.*

For more information circle **202** on inquiry card.

Magnetic Storage Drum

New "Wharf Mark III Storage Unit" capacity is 8193 words of 32 binary digits (over 250,000 bits). Its



256 heads, mounted in eight columns, have individual adjustment and are easily removed and replaced. Max. speed of 6000 rpm. gives a digit rate of 1000 kc./s.—*Imtra Corp., 58 Charles St., Cambridge 41, Mass.*

For more information circle **203** on inquiry card.

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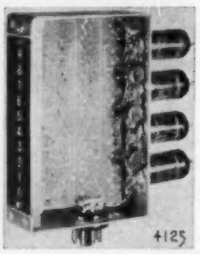


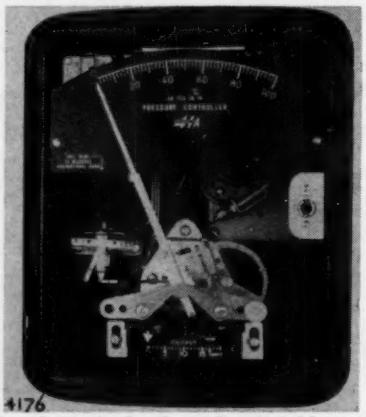
New "Types A and B" digital decade counters, each available in three variations, employ printed circuits for low operating temperature and long life. "Type A" has staircase output of voltage proportional to count, for recording on maker's "Direct Writing Oscillograph," etc.; "Type B" has four-line coded output for operating mechanical printers, etc.—*Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.*

For more information circle **204** on inquiry card.

PROCESS CONTROL and MONITORING

Indicating Controller

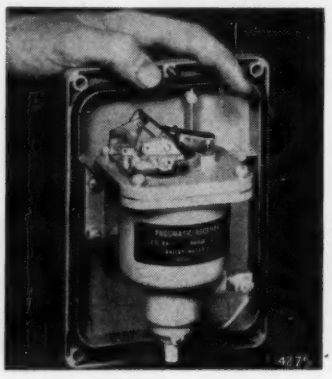
New "Model 41A Pneumatic Controller" replaces "Model 41, provides sharp on-off or narrow-band proportional control of such variables as temperature, pressure, liquid level and humidity. Proportional unit (adjustable from 0.25 percent to 25 percent of scale) relies on air jet rather than bellows-actuated follow-up action.—*The Foxboro Co., Foxboro, Mass.*



For more information circle **205** on inquiry card.

Plug-in Receiver for Multiple Recording

New Pneumatic Receiver receives transmitted pneumatic signals of a measured variable (from any make pneumatic transmitter, 3-15 or 3-27 psig.) and drives a recording pen. Arbitrary mounting of one to four units in one recorder made possible by plug-in pin-positioned construction and indexed drive arm. Each unit factory calibrated to better than 0.5 percent, sensitive to 0.01 psi.; compensated for



ambient temperature variations.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.*

For more information circle **206** on inquiry card.

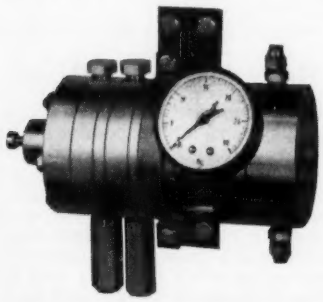
Plug-in Controller

New plug-in millivoltmeter controller housed in a horizontal case 19 in. wide permits stacking several instruments in a standard relay rack; is available with on-off, two-position and three-position modes of control. Three-position form incorporates a dual index and provides a neutral zone adjustable from 0 to 100 percent of full-scale (wide-zone model) or 0 to 10 percent of full-scale (narrow-zone model). Other features: galvanometer can be shipped separately to decrease possibility of damage during transportation, and it is possible to check calibration without disconnecting wiring. —*Industrial Div., Minneapolis Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **207** on inquiry card.

Pneumatic Transmitter

New "Model ATD BalanCel" employs force-balance principle whereby output pressure changes are exactly

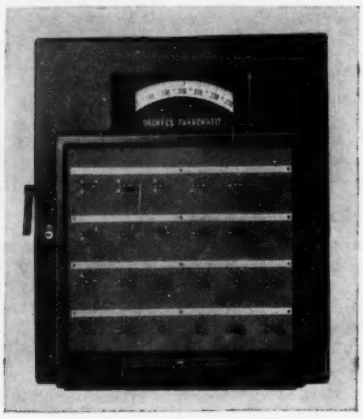


proportional to loading-pressure changes. Output may be direct or inverse function of a single loading pressure or of difference or sum of more than one loading pressure. —*Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.*

For more information circle **208** on inquiry card.

Multipoint Indicator

New "Type HJ" scans a number of process variables by manual switching on front panel. It may be used with provision for measuring up to 48 dif-



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For Large Vacuum Systems, or Fast Evacuation

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mm of Hg. Microns	5-L		10-L		25-L		50-L		100-L	
	Sec	Min	Sec	Min	Sec	Min	Sec	Min	Sec	
10^{0} — 1000	7		15		32	1	6	2	20	
10^{-1} — 100	9		18		49	1	36	3	30	
10^{-2} — 10	14		29	1	7	2	24	4	55	
10^{-3} — 1	22		45	1	30	3	20	7	3	
10^{-4} — 0.1	29	1	0	2	30	5	6	11	6	

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For more information circle **46** on inquiry card.

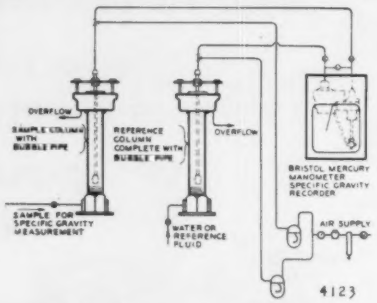
NEW INSTRUMENTS

ferent circuits, or in conjunction with a multipoint strip-chart recorder to obtain an intermittent record. It features (1) rotating scale 32¾ in. long; (2) continuous standardization against a permanent magnet, reducing manual operations associated with conventional instruments of this type. Available as a d-c. potentiometer or as an a-c. bridge.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **209** on inquiry card.

Specific Gravity Meters

New Specific Gravity Meters for liquid solutions, mixtures and slurries, operate by comparing pressure neces-



sary to displace a given head of sample liquid in a bubbler pipe, with pressure necessary to displace an equivalent head of water. Instruments can be calibrated in SG, Twaddell units, degrees Baumé, etc.; are factory calibrated for liquid in question.—*The Bristol Co., Waterbury 20, Conn.*

For more information circle **210** on inquiry card.

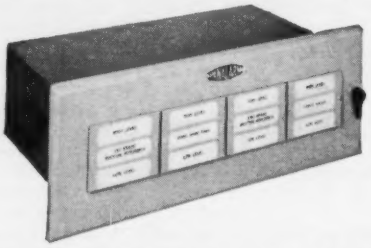
Plastic Conductivity Cells

New plastic-bodied conductivity cells are available as either threaded or dip types, with wide choice of electrodes (platinum, nickel and carbon materials); cell constants from 1/100 to 100; suitable for use in strong alkali or acid solutions; withstand temperatures up to 100 C.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **211** on inquiry card.

High-Low Annunciator

New audio-visual annunciator is compact: utilizes one plug-in relay unit for each three-light high-low sta-



tion. Top window designates "high" off-normal, middle window "normal," and lower window "low" off-normal. All alarms operate with a common audible signal, common flasher and utilize a common acknowledgment button. When operator presses acknowledgment button, audible alarm is silenced and the flashing signal becomes steady, remaining ON until conditions return to normal.—*Panalarm Div., Panellit, Inc., 7401 Hamlin Avenue, Skokie, Illinois.*

For more information circle **212** on inquiry card.

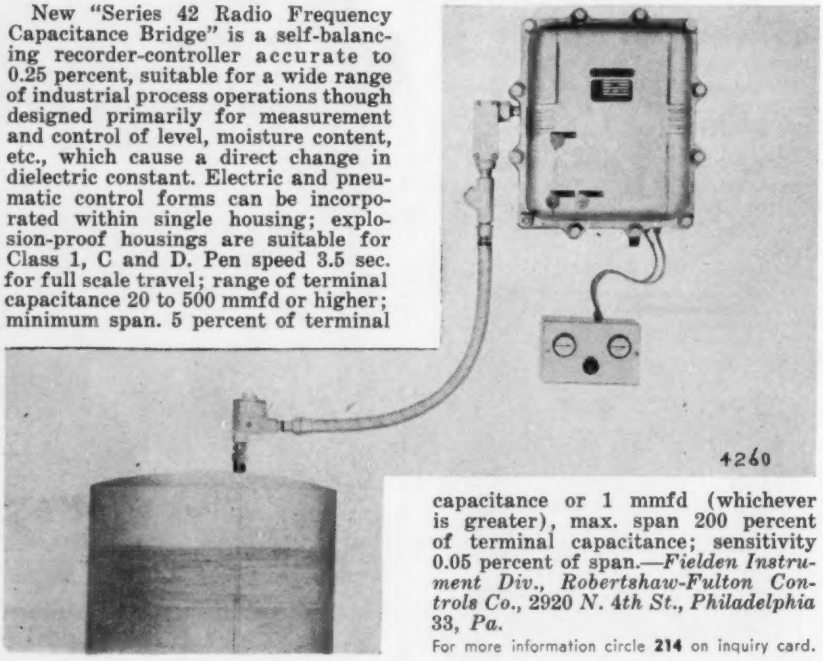
Recorder Chart Paper

New "Humitex" is a new type of chart paper whose properties improve legibility of records. Special sizing agents permit sharp recording without "feathering." Scale markings and time arcs are printed in a neutral gray for vivid contrast with colored recording inks. Circular-chart eccentricity tolerance between hub hole and scale circles is less than 0.002 in.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **213** on inquiry card.

Industrial Process Recorder-controller

New "Series 42 Radio Frequency Capacitance Bridge" is a self-balancing recorder-controller accurate to 0.25 percent, suitable for a wide range of industrial process operations though designed primarily for measurement and control of level, moisture content, etc., which cause a direct change in dielectric constant. Electric and pneumatic control forms can be incorporated within single housing; explosion-proof housings are suitable for Class 1, C and D. Pen speed 3.5 sec. for full scale travel; range of terminal capacitance 20 to 500 mmfd or higher; minimum span. 5 percent of terminal



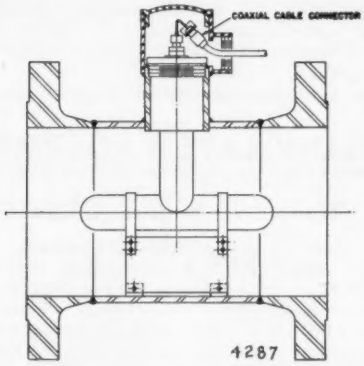
capacitance or 1 mmfd (whichever is greater), max. span 200 percent of terminal capacitance; sensitivity 0.05 percent of span.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St., Philadelphia 33, Pa.*

For more information circle **214** on inquiry card.

Process-stream Monitor

New "Capacitance Product Analyzer," said to be "often referred to as the 'Magic Eye for Pipe Lines'," is a

capacitance-sensitive crystal-controlled oscillator utilizing a variable inductor, reversible motor and power supply unit, all mounted in a recorder

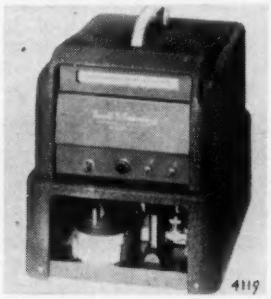


case. Choice of type of probe assembly depends upon application.—*Instruments, Inc., 122 N. Madison, Tulsa, Okla.*

For more information circle **215** on inquiry card.

Gas Sampling Unit

New "Model Y-101" comprises motor-driven pump, filter, flow indicator, valves, and 20-ft. power cord, mounted



and interconnected in an aluminum case; may be easily attached to "Model C2P Oxygen Analyzer" (as illustrated) or can be supplied with a handle for independent operation.—*Arnold O. Beckman, Inc., 1020 Mission St., South Pasadena, Calif.*

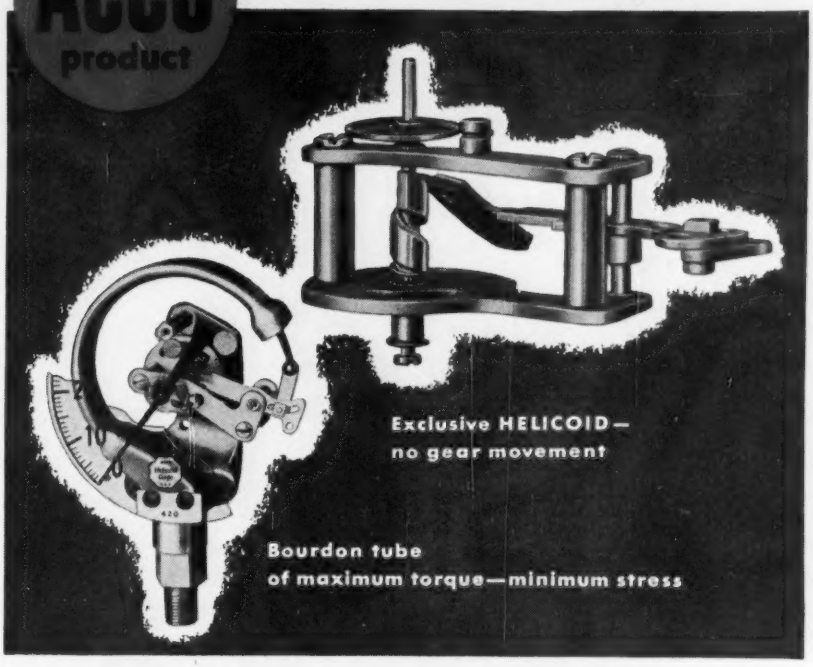
For more information circle **216** on inquiry card.

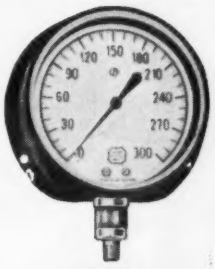
Level Controller

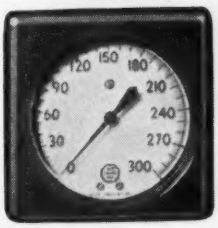
New "Model DP" combines capacitive level sensing with electronic controls terminating in air-pressure command to diaphragm-motor valve; is

an ACCO product

Helicoid Gages







Why HELICOID Costs Less Per Gage, Per Year

HELICOID Gages have many unique and exclusive features which result in enduring accuracy and savings in maintenance cost. They cost less per gage, per year.

Only HELICOID Gages, for instance, have the Helicoid Movement . . . a simple cam and roller design which has no gear teeth to wear out. Bourdon tubes used in HELICOID Gages are carefully designed to give maximum torque and minimum stress . . . promoting the greatest possible endurance life. They withstand many millions of pressure pulsations without stretching, leaking or cracking.

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For more information circle **47** on inquiry card.

Only one system is best for you

We've assembled dozens of instrumentation systems around our SADIC Analog-to-Digital Converter . . . and no two have been exactly alike! Each started from an exhaustive study of user requirements . . . each represented the most practical solution to a particular set of problems. And whether slated for static and dynamic testing, chemical analysis, or process control, every one of these data-processing systems has effected impressive savings both in dollars and man-hours . . . very often paying for itself in mere weeks.

How this type of tailor-made instrumentation can go to work for you is told in our new Systems Brochure . . . Send today for CEC-1304-X12.

Here's a typical SADIC Data-Processing System designed for a major aircraft manufacturer and used on static testing. Systems like this have saved hundreds of computation man-hours on a single test. Here are its basic functions . . . *all of them automatic . . .*

. . . Scans up to 100 strain-gage channels in any sequence after START button is pressed

. . . Balances each channel . . . eliminates manual potentiometer adjustments

. . . Reads out digital values at average rate of 25 channels per minute . . . at 0.1% full-scale accuracy

. . . Resolves ±1 mv input signals into ± 1,000 discrete parts . . . i.e., maximum sensitivity is 1 microvolt per count

. . . Controls sensitivity factor on all channels independently

. . . Punches pre-set constants and outputs of all channels on standard teletype tape, ready for automatic tabulation or conversion to punched cards

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ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

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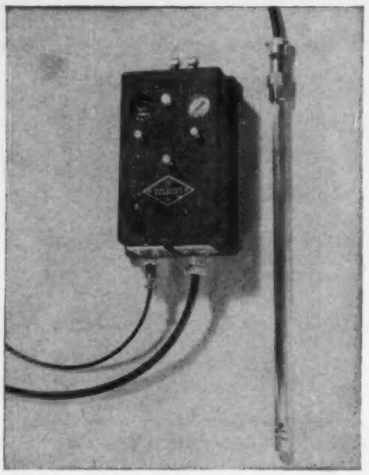
Sales and Service Offices Located in: Albuquerque, Atlanta, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, Seattle, Washington, D. C.

For more information circle **48** on inquiry card.



applicable to most non-adhesive chemicals, milk, oils, and all condensed gases at temperatures from 500 to –425 F.—*—Thermo Instruments Co., 1310 County Road, Belmont, Calif.*

For more information circle **217** on inquiry card.

FLOW-RATE & VOLUME

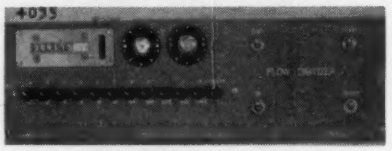
Hot-wire Anemometers

New line of three hot-wire anemometers covers 0-100-kc. frequency range for study of mean and fluctuating air velocities. "Model CT-100KC," 0-100-kc., 0.0002-in. wire, self-compensating constant-temperature circuit. "Model CT-1000CPS," 0-1000 cps., 0.0001-in. wire, constant-temperature type. "Model CC-100KC," 10 cps. to 100 kc. depending on wire size; constant-mean-temperature; servo controlled, constant-current anemometer employing *RC* compensation.—*Clarke H. Joy Co., Bay Village, Ohio.*

For more information circle **218** on inquiry card.

Flow Integrator

New "Model 25 Flow Digitizer" converts the digital output of maker's "Flow Sensing Element" to gallons, pounds or other desired units of flow. Instrument error is virtually elimi-

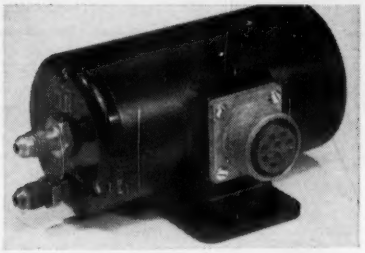


nated; system is capable of measuring total flow with an accuracy of 0.5 percent over wide ranges and an accuracy as high as 0.1 percent at fairly constant flow rates. Eleven binary dividers give scale of 2048. Thus, by depressing proper combination of buttons on instrument keyboard, it is possible to select appropriate conversion factor for any "Flow Sensor" with a maximum error of one part in 2048. Total flow is indicated on a six-digit mechanical register and on two decade-counting glow-transfer counting tubes.—*Potter Aeronautical Co., Route #22, Union, N. J.*

For more information circle **219** on inquiry card.

Differential-pressure Pickup for Air Flow

New dual-element air-flow differential pressure pickup has two metal bellows actuating sliders of paired precision voltage dividers. One bellows is

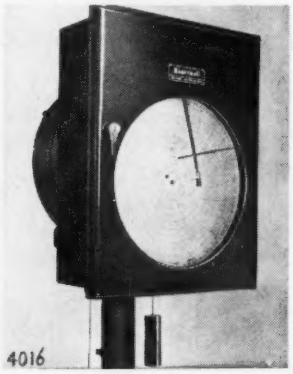


connected to impact pressure line from Pitot or Venturi; the other bellows to static pressure. Outputs of the four voltage dividers are individually brought out to terminals, providing individual access to dynamic or to static data.—*Technology Instrument Corp., Acton, Mass.*

For more information circle **220** on inquiry card.

Water and Sewage Flow-rate Meter

New redesign of maker's float-actuated flowmeter meets measurement and control needs of sanitary engi-

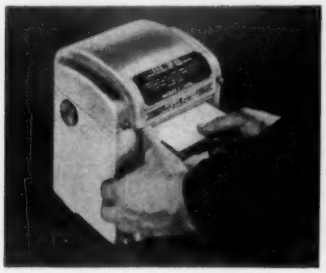


neers; is capable of holding its calibration indefinitely; may include pneumatic control and transmission.—*Industrial Div., Minneapolis-Honeywell, Philadelphia 44, Pa.*

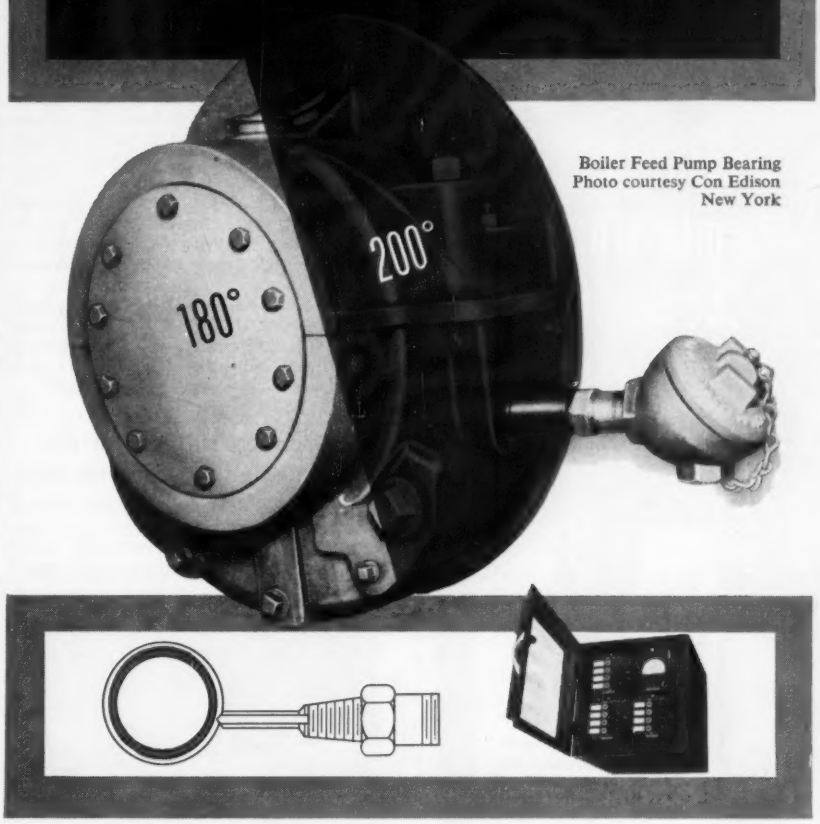
For more information circle **221** on inquiry card.

Liquid Meters with Ticket-printing Feature

New "Print-O-Meter" automatically stamps a ticket with number of gallons or pounds of liquid ingredients delivered to a batch or process; also prints letters and serial numbers on ticket to identify operator, batch, etc. Though new to industrial field, it is



How Omniguard overheat protection can double motor bearing life



Boiler Feed Pump Bearing
Photo courtesy Con Edison
New York

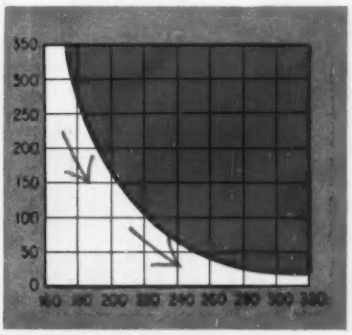
Any way you look at it, Omniguard becomes a necessity for today's high-speed automatic plant equipment. Omniguard signals *instantly* when an overheat condition is near—*before* valuable equipment or processes are harmed.

Recent studies prove, for example, that a mere 20° increase above 180°F. cuts in *half* the bearing life of rotating equipment. And this is just one instance of the devastating effects of overheat that EDISON Omniguard prevents.

Omniguard focal point is a panel easily understood at first glance—without complex gadgets—linked directly to possible trouble spots by resistance temperature detectors. Remote control indication is available too.

Omniguard's low cost is achieved 3 ways: Modular construction permits control of as few as four points or as many as are needed. Installation costs are 50 per cent less than any previous system—and maintenance is virtually nil.

You'll find it well worth your while to investigate Omniguard—a remarkable development from the world-famous EDISON *Laboratory.*



This study, published in *Electrical Manufacturing*, shows the effects of temperature vs. fatigue life of a tin-base babbitt sleeve bearing at a unit load of 2000 psi.

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For more information circle **49** on inquiry card.

Viking
miniature
connectors

DESIGNED FOR
LONG, RELIABLE
SERVICE LIFE

VIKING circular types. Positive polarization and shielding. Simple locking device mates units against vibration. One to four contacts on small units—5 to 9 on large units.

VIKING printed circuit receptacle. Increases your circuits—unit shown has 20 contacts, and is interchangeable with 18-contact types. Extremely strong contacts, pierced or unpierced.

Hermetic sealing is available on the circular and rectangular series. Write for literature on these or the complete line of VIKING connectors.

VIKING
ELECTRIC
1061 INGRAHAM STREET
LOS ANGELES 27, CALIF.

For more information circle **50** on inquiry card.

NEW INSTRUMENTS

similar to maker's commercial "Print-O-Meter" on tank trucks. It is available with maker's "Type S Industrial" meters in sizes from 1 to 4 in., for flow rates from 5 to 500 gpm.; can also be combined with "Auto-Stop" and "Auto-Switch" registers.—*Neptune Meter Co., 19 W. 50th St., New York 20, N. Y.*

For more information circle **222** on inquiry card.

TEMPERATURE

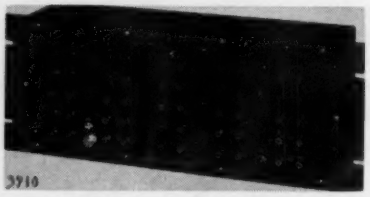
Thermometric Resistors

New extremely-accurate glass-protected platinum-wound resistance spirals, for precise temperature measurement over range of –200 C to 550 C. (–364 F. to 1022 F.), have a guaranteed accuracy of 1 C.; can be shipped from stock. Accessories (wells, heads, etc.) 60-day delivery. Also available: a special high-temperature resistance element encased in an appropriate ceramic envelope for measuring temperatures up to 750 C. (1382 F.).—*Charles Engelhard, Inc., 850 Passaic Ave., East Newark, N. J.*

For more information circle **223** on inquiry card.

Power & Balance Unit for Temperature-measuring

New "TME" provides high signal voltages required for operating telemetering systems, recorders and oscillographs; allows flexibility of measurement over various ranges without stocking many probes; provides range and sensitivity adjustments for 25 measuring channels. Available temperature probes are high-speed resistance units, range –70 to 500 F., various configurations.—*Arnoux Corp., Dept. IA-1, 1357 S. Hawthorne Blvd., Hawthorne, Calif.*



For more information circle **224** on inquiry card.

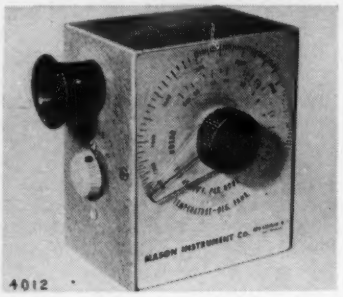
Thermoscopic Liquids

New "Tempilaq" suspensions for 463 and 468 F. have been added to maker's line of surface temperature indicating materials.—*Tempil Corp., 132 W. 22nd St., New York 11, N. Y.*

For more information circle **225** on inquiry card.

Optical Pyrometer

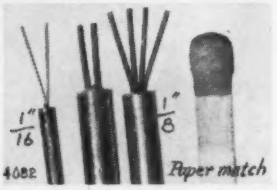
New optical pyrometer for the 1000-2500 F. range; weighs 20 oz., is 3x4x5; in.; requires no connection; has 9-in. scale easily read to within 10 F. degrees in seconds by brightness match; and has built-in "calibrating meter," also a scale of Orton cone temperatures.—*Mason Instrument Co., 29 Elm Ave., Mount Vernon, N. Y.*



For more information circle **226** on inquiry card.

TC Wires & Extensions

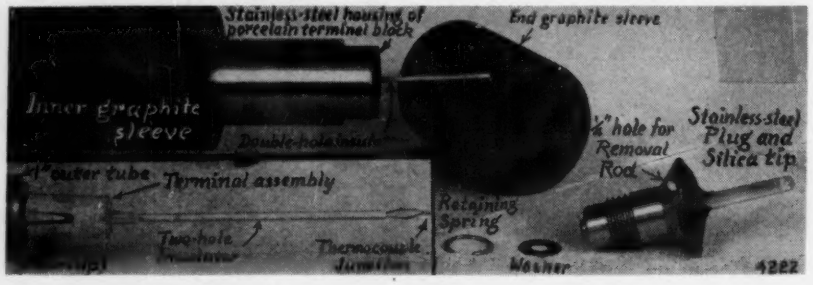
New "Ceramo" thermocouple and TC extension wires are magnesium-oxide insulated, metallic-clad, rugged, readily formed, made in various materials, in several gages and ODs and in different types of seamless metal tubing over-all; all to standard ISA calibration accuracies. Can be bent on a radius as small as their diameter. Conduits unnecessary. "Ceramo" is made also in single- or multi-conductor cables.—*Thermo Electric Co., Inc., Saddle Rover Township, Rochelle Park P. O., N. J.*



For more information circle **227** on inquiry card.

Immersion Thermocouple

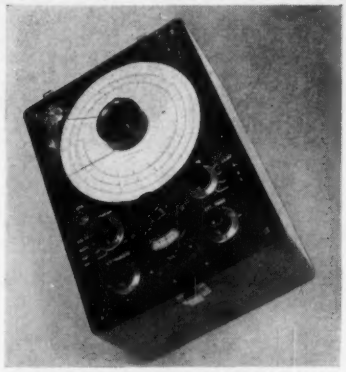
New immersion TC enables operators of open hearth and electric furnaces to measure bath temperatures on a full-time operating basis. Expendable parts can be replaced at furnace.—*Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Penna.*



For more information circle **228** on inquiry card.

Potentiometer

New "Model 9A Pyrotest" checks and calibrates industrial temperature instruments, each for five tempera-

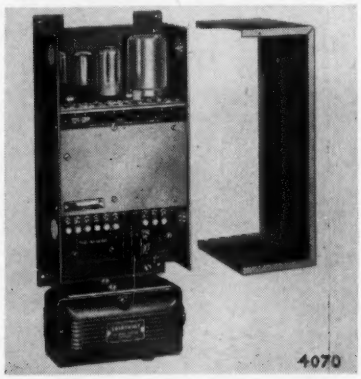


ture ranges; includes millivolt range; has cold junction compensation. Accuracy is 1/6 of 1 percent of scale span. —*Technique Associates Inc.*, 211 *E. South St, Indianapolis* 25, *Ind.*

For more information circle **229** on inquiry card.

Pneumatic Transmitter for Millivolt Inputs

New "Type T3C Thermocouple-Air Converter" converts d-c. millivolt input signals to air pressure of 3-15 psig.; can be furnished with electro-

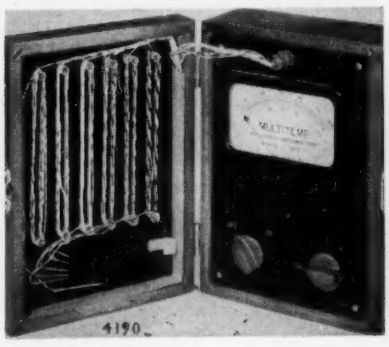


pneumatic transducer in an explosion-proof housing. Span is 2 to 50 mv.; span accuracy 1 percent; reproducibility 0.25 percent of span, ultimate sensitivity better than 0.01 percent of span.—*The Swartwout Co.*, 18511 *Euclid Ave., Cleveland* 12, *Ohio.*

For more information circle **230** on inquiry card.

Thermistor Thermometer

New "Multitemp," originally designed for medical research, can be furnished to cover any range from



HOKE

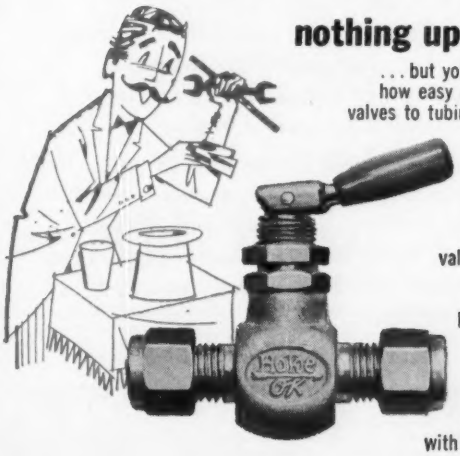
Flow Sheet

Hoke reports on fluid control

we're giving you the needle

. . . to help you control small flow rates easily and accurately. The needle point in a Hoke Metering Valve is just 8° wide and it takes 20 turns of the handle to move the point 3/8 of an inch, the effective throttling length. In addition to this precise control, the Metering Valve has an O-ring stem seal (. . . so tight it'll pass a Helium Leak Test) and is available for instrument panel mounting.

Interested? . . . write for catalog and data sheets.



nothing up our sleeve

. . . but you'll be amazed to see how easy it is to connect Hoke valves to tubing the Swagelok way. No swaging, no sweat, no swearing . . . in fact, it's no trick at all to achieve a permanent valve-to-tube connection with a turn and a quarter of a wrench. Hoke makes precision needle valves, on-off toggle valves, check valves — in brass and stainless — equipped with Swagelok tube ends.

Ask for Bulletin SV854.

HOKE

HOKE INCORPORATED

Fluid Control Specialists

231 S. DEAN STREET, ENGLEWOOD, N. J.

For more information circle **51** on inquiry card.

Time the flow of
Gas . . . Liquids . . . Solids
in Split-Second Intervals
with the

POST INTERVAL TIMER

The Post electronic "Interval Timer" permits fractional second timing of any industrial operation. One, or more, different functions can be controlled by various models.

60 Cycle, line-current, is converted to 120 impulses per second. Desired "action-intervals" can be set in increments as fine as 1/120th of a second, and the timer will automatically time the operation. Controls are easily set . . . stay in position.

Filling operations, conveyor feeding, etc. are ideally solved by this latest Post development. *Write for details.*

POST

Electronic Products Division
Dept. 551
MACHINERY CO.
Beverly, Mass.

For more information circle **52** on inquiry card.

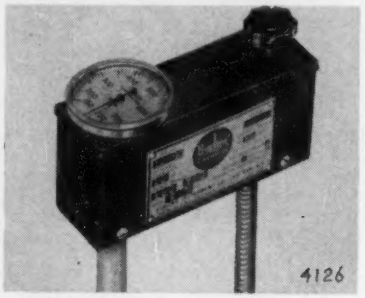
NEW INSTRUMENTS

–100 to 600 deg. F. and in accuracy to within 0.005 F. deg. (depending on range); can be connected to any inexpensive recorder; employs miniature thermistors which permit its use for micro-temperature studies; can be supplied with any number of leads.—*G. M. Mfg. Co., 50 W. 3rd St., New York 12, N. Y.*

For more information circle **231** on inquiry card.

Temperature Controller

New "Model LD-1S" for lab and industrial use combines an independent



dial thermometer with a differential expansion type automatic controller. Switch is rated at 15 amp. 125-250 v.ac. Flange or threaded fittings; tube of brass or stainless steel, ⅝-in. O.D. x 14-in. long.—*Burling Instrument Co., 16 River Rd., Chatham, N. J.*

For more information circle **232** on inquiry card.

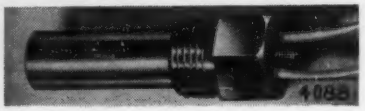
Oven Thermometer

New "Gradu-Temp" aids appliance man: no stooping and peering into hot ovens; tests are made with oven door closed. Seven-color dial has neat drawings of good cooking. Temperature range 100 to 600 F.; millivoltmeter is compensated for cold junction and copper errors, has two millivolt ranges, 0-50 and 0-500, for checking pilot safeties. —*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **233** on inquiry card.

Cartridge Thermostat

New "Model FM-132" is said to be the only metal thermostat that will withstand mechanical clamping of cartridge without altering set calibration. Complete lack of reliance on expansion of outer shell for make and



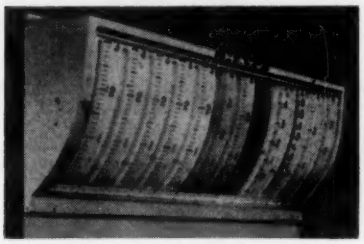
break of contacts is said to open "an entirely new concept in mounting cartridge type units." Operating ranges available from 0 to 600 F. Rated at 1200 w., 115-230 v.ac. non-inductive load.—*George Ulanet Co.*, 418 *Market St., Newark* 5, *N. J.*

For more information circle **234** on inquiry card.

PRESSURE & VACUUM

Edgewise Gages

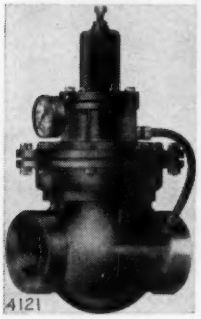
New diaphragm-operated "Vertiscale Gages" are a completely new design in draft gages; can also be em-



ployed for remote indication of pressure, flow, level, temperature, O_2 in flue gases, etc. Among features: removable units; "one-man" zero check; fluorescent lighting; Lucite scales; large label space; magnet-closed access door at case bottom.—*The Hays Corp., Michigan City, Ind.*

For more information circle **235** on inquiry card.

Back-pressure Controller

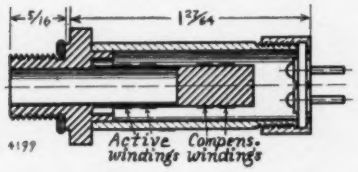


New "Type 73-22 Back Pressure Regulator with Integral Controller" provides close regulation and complete closure; provides closer sensitivity to pressure fluctuations than can be obtained with weight-loaded type and has a much wider range of adjustment than direct-spring-loading type. Available sizes: 2-in. screwed globe, 3-in. and 4-in. flanged globe; control range 5 to 125 psi.; temperatures to 165 F.—*Black, Sivalls & Bryson, Inc.*, 7500 *E. 12th St., Kansas City* 26, *Mo.*

For more information circle **236** on inquiry card.

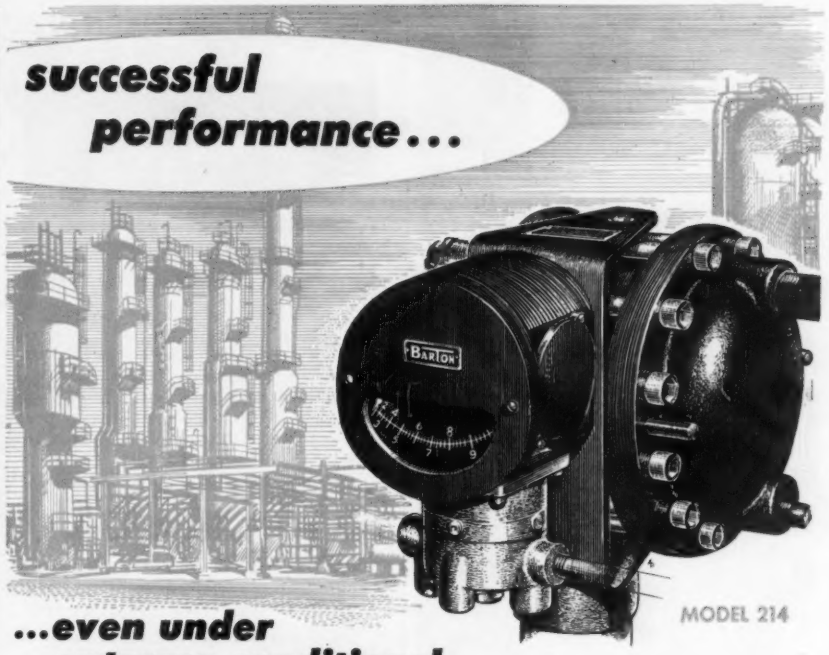
Pressure Pickup

New "Type PS-20" miniature pressure pickup, said to be "characterized by ruggedness, simplicity and



high frequency response," has for elastic member a small metallic cylinder with resistance gage windings on outside; can measure static and dynamic pressures from 50 to 5,000 psi.—*Hathaway Instrument Co.*, 1315 *S. Clarkson, Denver, Colo.*

For more information circle **237** on inquiry card.



...even under extreme conditions!

BARTON DP TRANSMITTERS accurately transmit flow, liquid level, and/or differential pressure with high speed, high sensitivity and low air consumption, regardless of temperature variation, pulsation, and severe over-range. Direct mechanical indicator insures continuity of operation on air failure; and together with accessible adjustments, simplifies field calibration. **For further information request bulletin 214-1 or contact BARTON sales engineers, located in most principal cities.**

TURNING OPERATIONS ON BARTON FLOWMETER BODY HEADS

Differential pressure ranges from 20 "WC to 400" WC. Pressures to 4500 psi. Static pressure pen is optional.

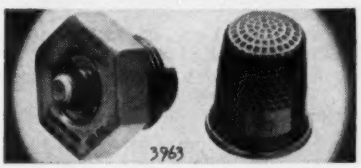
MODEL 202 RECORDER

BARTON INSTRUMENT CORPORATION
INDUSTRIAL INSTRUMENTS
1429 SOUTH EASTERN AVENUE · LOS ANGELES 22, CALIFORNIA

For more information circle **53** on inquiry card.

Pressure Pickup

"Model 2501 Dynamic Pressure Pickup" features piezoelectric ceramic primary element which obviates need of external power and permits use of cables up to several hundred feet long. Available in 3 ranges: 0-500, 0-1000, and 0-2500 psi. Full-scale output over 15 volts. Natural frequency ranges



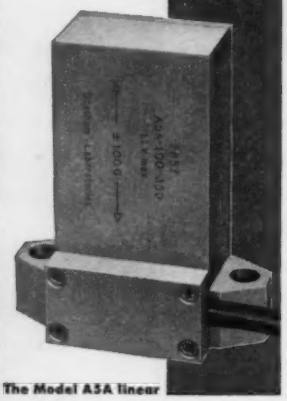
upward from 35 kc. permitting measurement of rise times of order of 10 microseconds.—*Endevco*, 180 *E. California St., Pasadena, Calif.*

For more information circle **233** on inquiry card.

Pressure Pickups

New "Baroresistors" are pressure pickups of variable-resistance type, said to maintain their accuracy while being subjected to plus and minus 10 *G* vibration at 500 cps. Models for missile use operate under vibrations of plus and minus 25 *G* from 0 to 2000 cps. Unwanted response to resonant-frequency vibrations is said to have been suppressed by use of an ex-

Specify
The
Accelerometer
That
Has
Acknowledged
Merit



The Model A5A linear accelerometer is available in ranges from ±5g to ±200g.

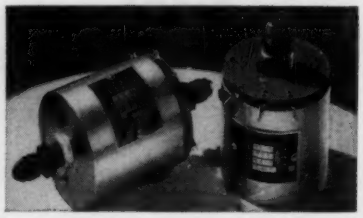
Employing the principle of the unbonded strain gage, Statham accelerometers are suitable for static and dynamic measurements and are offered in a wide variety of designs for each of the many fields requiring measuring instruments for acceleration and vibration studies.

Please request Bulletins AL-1 and AT-1

Statham
LABORATORIES
Los Angeles 64, Calif.

For more information circle **54** on inquiry card.

NEW INSTRUMENTS

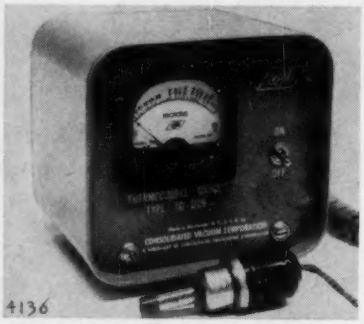


tremely rigid structure, completely balanced mechanism, and stiff springs, whereby response to a small step change in pressure occurs in about one millisecond. Ranges from 14.7 psia. to 60 psig., also differential pressure.—*Trans-Sonics, Inc., Bedford Airport, Bedford, Mass.*

For more information circle **239** on inquiry card.

Vacuum Gage

New "Type TG-029" single-station thermocouple gage, designed around a printed circuit (and consequently

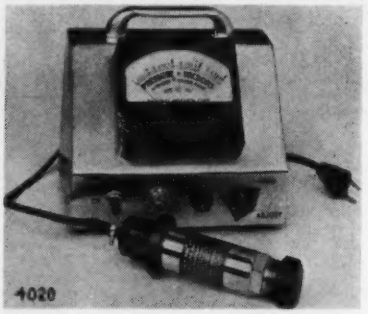


priced considerably lower than previous single-station model) is calibrated for air with one scale direct-reading 1 to 1000 microns Hg; is not harmed by exposure to atmospheric pressure; uses new and improved "Type TG-77" gage tube eliminating fragile junction weld.—*Consolidated Vacuum Corp., Rochester 3, N. Y.*

For more information circle **240** on inquiry card.

Vacuum Gage

New "Model 515 Alphatron" indicates pressures from 1 micron to 10 mm. Hg on one four-decade logarith-

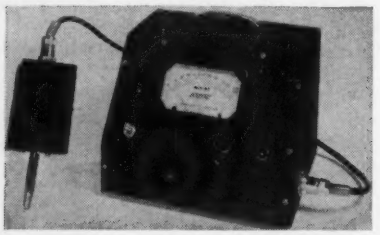


mic scale; cannot be damaged by exposure to atmospheric pressure because ion source operates at room temperature and at zero potential.—*Naresco Equipment Corp., 160 Charlemont St., Newton Highlands 61, Mass.*

For more information circle **241** on inquiry card.

Vacuum Gage

New "Model II Televac" of thermal conductivity type, utilizing coated elements which minimize calibration



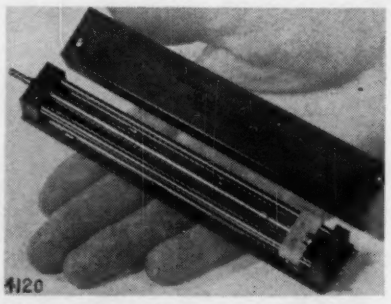
drift due to contamination. Gage tubes are interchangeable. Unit is fully compensated against line voltage and ambient temperature changes. Range 1 to 1000 microns Hg.—*George E. Fredericks Co., 507 Ann St., Bethayres, Penna.*

For more information circle **242** on inquiry card.

DISPLACEMENT, FORCE, VIBRATION

Linear-motion Pickup

New "Linipot" converts translational motion into an electrical signal, features linearity of 0.05 percent with

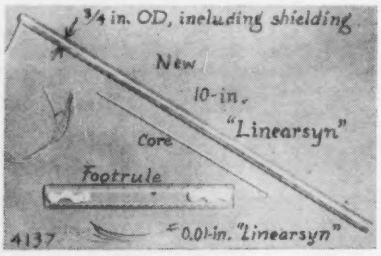


4-in. stroke; 1-oz. operating force; resolution factor of less than 0.001 in.; resistance range 500 to 50,000 ohms; life rating 1,000,000 cycles.—*Benson-Lehner Corp., 2340 Sawtelle Blvd., Los Angeles 64, Calif.*

For more information circle **243** on inquiry card.

Linear-motion Pickup

New "Model 7S5 Linearsyn" converts translation into proportional voltage, is of shielded differential-



transformer type for 400-cps. excitation voltage. Stroke range is 10 in. (plus and minus 5 in. about null position). Output impedance of less than 2000 ohms makes it possible to use unit with relatively long cable runs.—*Control Components Co., 1 Holden St., Brookline 46, Mass.*

For more information circle **244** on inquiry card.

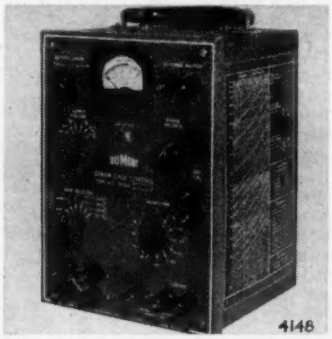
Indicator for LVDTs

New "Model 300" indicates force, translation, pressure, stress, strain, flow, weight, size, etc., measured by means of differential transformer pickups and also provides output suitable for operation of direct-writing recorders and auxiliary alarm and control devices.—*Daytronic Corp.*, 216 *South Main St., Dayton, Ohio.*

For more information circle **245** on inquiry card.

LVDT Pickup Control

New "Type 332 Differential Transformer Control" is a self-contained unit designed for use with commercial



LVDT pickups in medium a-f. range. When used with maker's new "Type 324" CRO, it enables measuring static or dynamic displacements in region of plus or minus 25 microinches to 0.1 in. per major scale division of deflection. Combined noise and hum less than 200 uv. at output terminals.—*Allen B. Du Mont Laboratories, Inc.*, 760 *Bloomfield Avenue, Clifton, N. J.*

For more information circle **246** on inquiry card.

Load and Force Pickups

New "Series 140 Load Transducers," available in capacities from 500 to 50,000 lbs., combine proving-ring and differential-transformer principles, feature 1 percent linearity, frequency range from zero to 1000 cps., exceptional stability of calibration and zero point, negligible temperature error, and 1 percent accuracy of transmitted values.—*Daytronic Corp.*, 216 *South Main St., Dayton 2, Ohio.*

For more information circle **247** on inquiry card.

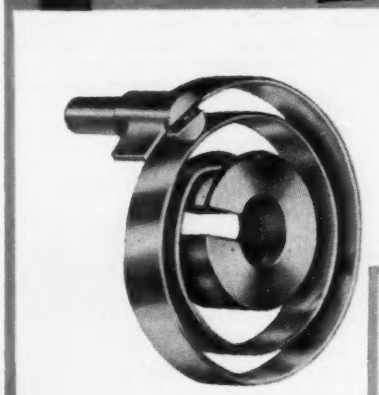
Wheel-force Dynamometer

New "R1040-1" used with maker's "Servometer" to measure forces applied to aileron and elevator controls, is a double-cantilever beam dynamom-

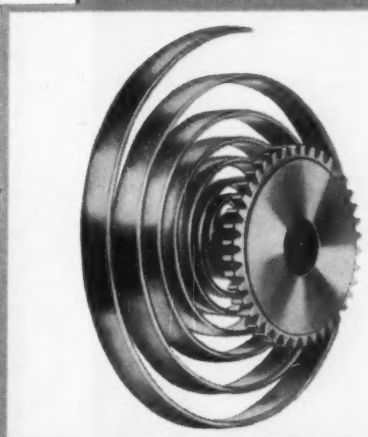
CHATILLON

SPIRAL SPRINGS

. . . better because they're temperature-compensated!



AVAILABLE IN PRACTICALLY ALL SIZES AND CAPACITIES



* Developed by Chatillon with the assistance of Professors A. V. DeForest of Massachusetts Institute of Technology and D. Sayre of Union College.

Chatillon Spiral Springs are unmatched for accuracy, sensitivity and strength . . . for low hysteresis and drift errors.

But what makes these springs unique is their constancy of spring characteristics in extreme temperatures. *Made of Iso-Elastic*, they are virtually unaffected by temperatures ranging from −50°F. to +150°F.*

This kind of spring performance takes know-how. That's why companies like Bendix, Pioneer-Central National Die Casting, etc., specify Iso-Elastic Spiral Springs in their instruments. Chatillon also makes Torsion, Compression and Form Springs in Iso-Elastic and standard alloys.

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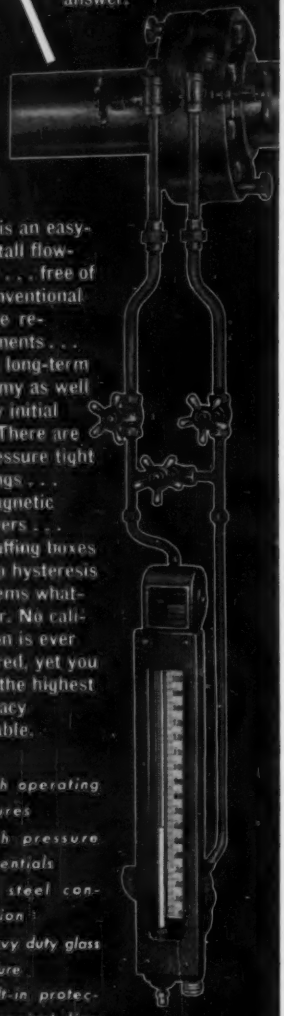
For more information circle **55** on inquiry card.

UNMATCHED ACCURACY
in direct flow indication

Wherever you seek simplicity and high accuracy in flow measurement at lowest cost, the Meriam "H" Meter is the well-known answer.



Here is an easy-to-install flowmeter . . . free of all conventional service requirements . . . giving long-term economy as well as low initial cost. There are no pressure tight bearings . . . no magnetic followers . . . no stuffing boxes . . . no hysteresis problems whatsoever. No calibration is ever required, yet you have the highest accuracy available.

★ High operating pressures
★ High pressure differentials
★ All steel construction
★ Heavy duty glass enclosure
★ Built-in protection against line surges

Write for Bulletin 18A

Meriam Manometer Instrumentation
...for pressures, vacuums, flows, liquid levels.

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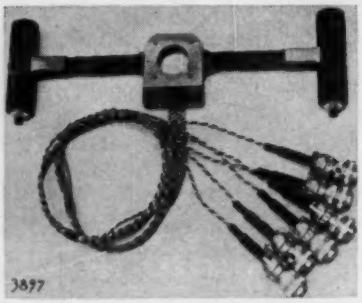
INSTRUMENT COMPANY
10920 Madison Ave. • Cleveland 2, Ohio

For more information circle **56** on inquiry card.

NEW INSTRUMENTS

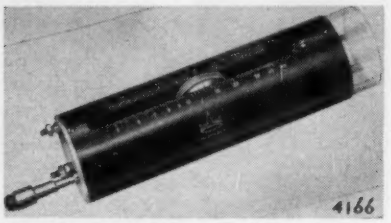


eter employing four strain gage bridges, each with four active arms. Voltage outputs of bridges are independent of load distribution applied on grips. (Original design work was by Wright Air Development Center.) —*Radiation, Inc., Melbourne, Fla.*

For more information circle **248** on inquiry card.

Vibrometer

New "Askania Two-reed Frequency Meter" is a compact (1-¾ in. dia. x 6-½ in.) instrument for measuring

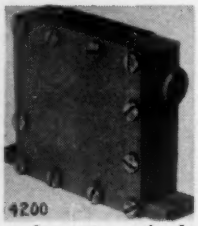


vibrations from 5 to 270 cps. with about 100x amplification. By means of a protruding shaft and a pulley, frequencies of torsional vibrations and rps. can be measured. Instrument is provided with terminals for measuring electrical oscillations.—*EPIC Inc.*, 154 *Nassau St., New York* 38, *N. Y.*

For more information circle **250** on inquiry card.

Acceleration Pickup

New "Type AMS-20A," for use with carrier-type instrumentation systems and available over a wide range of natural frequencies (0-1000 cps.) and sensitivities (0-500 *G*)



has for its moving element a single metallic ribbon or filament, under tension and in damping fluid, making possible any desired degree of damping and insuring vibration in only one mode without harmonic resonance. Filament deflection is measured by inductors connected in a four-arm bridge circuit giving low impedance output and obviating need for cathode-follower accessories.—*Hathaway Instrument Co.*, 1315 *S. Clarkson, Denver, Colo.*

For more information circle **249** on inquiry card.

Acceleration Pickup

New "Model GOH" is a voltage-dividing-resistor-type instrument, available in ranges between ±1 *G* and ±3 *G* inclusive. To maintain constant operating characteristics over a wide ambient temperature range, a thermostatically-controlled heater has been built in. Mass is supported by a parallelogram-type leaf spring, giving it a virtually friction-free straight-line motion along sensitive axis. Voltage-divider winding is platinum alloy wire wound on a Mycalex mandrel.—*Genisco, Inc.*, 2233 *Federal Ave., Los Angeles* 64, *Calif.*

For more information circle **251** on inquiry card.

TIME AND SEQUENCE CONTROL

Automatic Timer

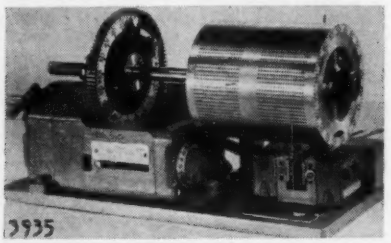
New "Model 1310A Long Time Delay Generator" provides continuously-variable intervals over an exceptionally wide range (20 usec. to 10 sec.). Long-term accuracy is 1 percent of

full-scale for each range (0.5 percent with standard modification available). Blocking oscillator pulses at reference and delay termination are 0.5 usec. wide, with an amplitude of at least 45 volts. Positive and negative variable-width pulses are also available.—*Electro-Pulse, Inc.*, 11811 *Major St., Culver City, Calif.*

For more information circle **252** on inquiry card.

Program Controller

New "Programonitor" counting and sequencing controller provides any number of intermediate switching points within count-cycle; counts revolutions, strokes or electric impulses;



operates at speeds to 4000 rpm. Two forms of program cylinders: (1) For momentary switching, provides any switching pattern by locating small self-locking pins in holes in cylinder; (2) for dwell switching, program cylinders cut to order, changes effected by easy interchange of cylinders.—*Counter & Control Corp.*, 5213 *W. Electric Ave., Milwaukee* 14, *Wis.*

For more information circle **253** on inquiry card.

Doelcam joins MINNEAPOLIS Honeywell

WE ARE PROUD to become the newest division of the world's largest producer of automatic controls. Our experienced staff of design engineers, our modern manufacturing facilities and our precision instruments all match the high standards set by Minneapolis-Honeywell. We shall continue to maintain our leadership as a quality manufacturer of servo components for bombing and navigational computers, fire control systems and missile stabilization and guidance systems. Whether your applications are of a military, laboratory or industrial nature, you may rely upon our instruments for measurement and control to continue to remain unsurpassed in a precision industry.

Doelcam
A DIVISION OF MINNEAPOLIS-HONEYWELL
SOLDIERS FIELD ROAD
BOSTON 35, MASS.

Instruments for Measurement and Control
Synchros • Gyros • Amplifiers • Microsyns • Servo Motors

SERVO MOTORS—All Navy Bureau of Ordnance Types —115 volts, 400 cps—fulfill rigid requirements of MIL-S-17087.

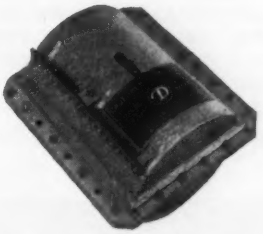
Write for Bulletin SM4

SYNCHROS — Sizes 11 through 31 — 115 volts, 400 or 60 cps — meet exacting requirements of MIL-S-16892 or FXS-1066.

Write for Bulletin S4

AMPLIFIERS—D-C Indicating Amplifier (shown here), Selected Range D-C Amplifier and Magnetic Null Indicator all use Doelcam Second-Harmonic Magnetic Converter in input stage for low drift and high sensitivity.

Write for Bulletin A4



GYROSCOPES — Cageable Free Gyro (shown here), Junior Rate Gyro, K Rate Gyro, Gyro Stable Platforms — used in guided missiles, aircraft flight evaluation systems and bombing and navigational computers.

Write for Bulletins K, JR and CFG4

For more information circle **57** on inquiry card.

You name the metal or plastic

WE'LL MAKE THE

Swagelok®

TUBE FITTINGS

EASY TO USE . . . . . .

NO SPECIAL TOOLS NEEDED

NO FLARING OR THREADING

From stock or on special order, you can get Swagelok Tube Fittings in any metal you require ranging from titanium to brass — *in fact, any machinable metal or plastic.* When you use Swagelok Tube Fittings every joint is leakproof. No bothersome small leaks to cause shutdowns. Tubing is rigidly supported, thereby avoiding vibration. No torque is transmitted to the tubing. Swagelok Tube Fittings can be used on heavy or thin wall tubing of every tube material, including plastic. Plus the fact that Swagelok joints are easier and faster to make. Get the facts now.

FREE: For complete information write for the Swagelok catalog. Address Dept. A-12

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Cleveland 10, Ohio

For more information circle **58** on inquiry card.

NEW INSTRUMENTS

NUCLEONICS

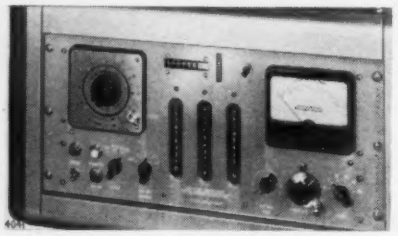
Nuclear Instruments

New line of nuclear instrumentation incorporates latest techniques. Based on Oak Ridge circuits, units have been redesigned for industrial and university applications: logarithmic amplifiers, linear amplifiers, period amplifiers, composite amplifiers, summation amplifiers, scalers, pulse height analyzers, power supplies for ion chambers, and compensated and parallel circular plate ion chambers, available singly, as complete consoles, or in multiple combinations.—*Daystrom Instrument, Archbald, Penna.*

For more information circle **254** on inquiry card.

Combination Decimal and Binary Scaler

New "Model 200" is said to be "designed to be used when no other scaler



will do the job satisfactorily. Yet it is so simple to operate, so versatile and so economical that it is practical for the most routine work as well."—*Radiation Instrument Development Lab., 2337 W. 67th St., Chicago 36, Ill.*

For more information circle **255** on inquiry card.

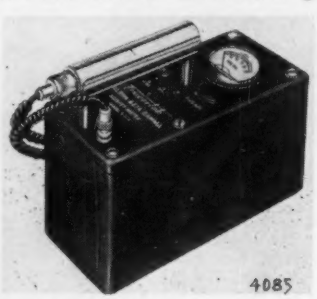
Scintillation Counters

New scintillation counter can be used with any of 12 different sealed light-tight crystal detectors for separately measuring alpha particles, beta particles, gamma rays, slow or fast neutrons, x-rays, etc. It contains a photomultiplier, a magnetic shield and a cathode follower (or a two-stage preamplifier) with low impedance output. Up to 50 ft. of cable can be used. Plateaus of 2 percent per 100 v. for an extent of 300 v. can be obtained.—*National Radiac, Inc., Newark, N. J.*

For more information circle **256** on inquiry card.

Survey Meter

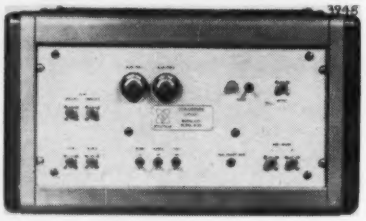
New "SU-14 Alpha Beta Gamma Survey Meter" is portable, waterproof, suited for use as a radiation dosage rate meter and as a monitoring instrument. Choice of two Geiger tube probes. Scale ranges 0.25, 2.5 and 25 mr/hr. and 500, 5000 and 50,000 cpm. Time constant automatically changed with scale range selected.—*Tracerlab, 130 High St., Boston 10, Mass.*



For more information circle **257** on inquiry card.

Coincidence Circuit

New "DZ4 Fast-Slow Coincidence Circuit," said to be latest improvement over earlier models used by Oak Ridge, has a definite short resolving



time advantage, permits use of single and multi-channel analyzers having considerable time uncertainty.—*Detectolab, Inc., 6544 Sheridan Road, Chicago 26, Ill.*

For more information circle **258** on inquiry card.

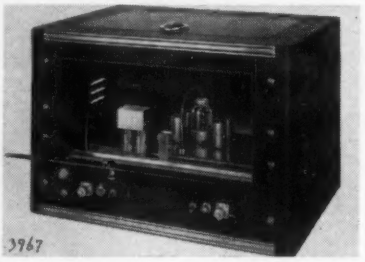
Survey Instructments

New line of eleven uranium prospecting instruments includes models from a pocket-size Geiger counter to "Master Scintillation Counter."—*El-Tronics, Inc., Fifth & Noble Sts., Philadelphia 23, Pa.*

For more information circle **259** on inquiry card.

Isotope Analyzer

New "Model ISA" performs rapid qualitative and quantitative analyses of isotope mixtures containing beta-

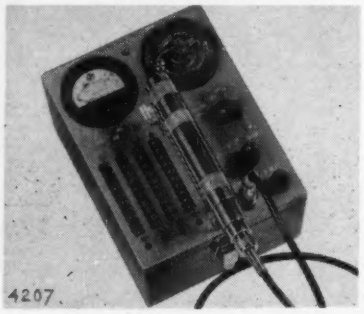


emitting components, embodies method based on absorption and scattering of beta rays in materials of high atomic numbers.—*Forro Scientific Co., 833 Lincoln St., Evanston, Ill.*

For more information circle **260** on inquiry card.

Survey Meter

New "Countmaster" Geiger counter permits field assay of radioactive substance and gives a timed count; weighs



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- **Largest Number of Body Materials**
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For more information circle **59** on inquiry card.

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For more information circle **60** on inquiry card.

NEW INSTRUMENTS

7¼ lbs. including probe and shield. Accurate counting range is claimed up to 12,000 counts per minute: "find" is flashed upon four rows of neon lights, where it remains until erased by operator.—*Hoffman Labs, Inc.*, 3761 *S. Hill St., Los Angeles* 7, *Calif.*

For more information circle **261** on inquiry card.

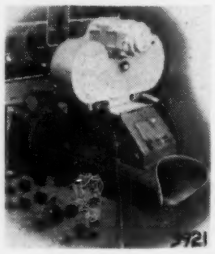
Gamma Survey Meter

New gamma survey meter comprises a new Neher-White ionization chamber on a 50-ft. cable for use with maker's "Radector"; permits accurate remote radiation measurement without binoculars or makeshift optical systems. New chamber is shock-isolated; operates over range of minus 65 to 250 F.; can be used continually submerged in water; measures intensities from 0.01 mr/hr. to over 100,000 r/hr. and is substantially energy-independent from 75 kev up.—*Jordan Electronic Mfg. Co., Inc.*, 119 *E. Union St., Pasadena* 1, *Calif.*

For more information circle **262** on inquiry card.

PHOTOGRAPHY

Oscilloscope Camera



New "Model OC-1" high-speed 35-mm. camera for continuous recording of scope traces features simultaneous binocular viewing and recording, illuminated identification card, and flashing lamp time reference. Film transport rate 1 to 300 ips.; lower speeds by gear substitution; higher speeds with special starting.—*Brea Instruments, P. O. Box* 248, *Brea, Calif.*

For more information circle **263** on inquiry card.

35-mm. Enlarger

New "Solar Stoway" 35-mm Enlarger features "from closet to work area in a minute"; F/3.5 2-in. coated enlarging, four-element Tessar type lens; exclusive non-actinic 16x19 in. extremely rigid baseboard; supports for roll film; provision for color filters; etc.—*Burke and James, Inc.*, 321 *S. Wabash Ave., Chicago* 4, *Ill.*

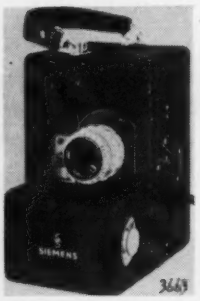
For more information circle **264** on inquiry card.

35-mm. Camera

New "Diax II a" has complete range of interchangeable lenses, coupled to a single-window superposed range/viewfinder. Coated click-stop objectives (made by Schneider, Germany) comprise: Xenagon 35-mm. f/3.5, Tele-Xenar 90-mm. f/3.5, and Tele-Xenar 135-mm. f/4. Synchro-Compur shutter speeds 1/500 to 1 sec., T&B.—*Karl Heitz, Inc.*, 150 *W. 54th St., New York* 19, *N. Y.*

For more information circle **265** on inquiry card.

16-mm.-record Camera

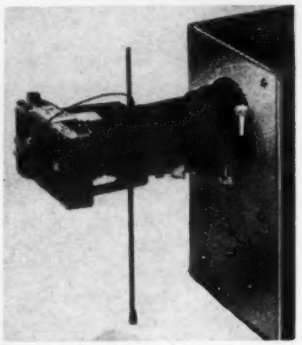


New "Siemens Recording Camera" (German-made) employs 16-mm. film available in many emulsions; takes 40 ft. yielding 1600 exposures; operates on 24 v.dc.; numbers exposures "1" to "50" and repeats automatically.—*Ercona Corp.*, 527 *Fifth Ave., New York* 17, *N. Y.*

For more information circle **266** on inquiry card.

Polaroid 'Scope Camera

New "Special 1:1 FPO Polaroid Oscilloscope Camera" mounts on any 'scope type electronic device having a

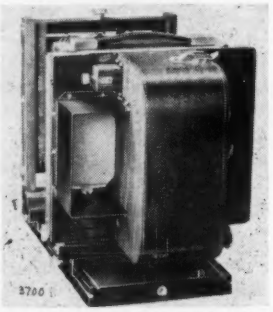


5-in. tube and a 5⅝-in. bezel; features special f/1.9 oscillo-anastigmat lens; shutter speeds of 1 sec. to 1/100 sec., time and bulb; print area 3 by 4 in.—*Fairchild Camera and Instrument Corp., Robbins Lane, Syosset, L. I., N. Y.*

For more information circle **267** on inquiry card.

Magazine-film Holder

New improved model of "Foto-Roll-70" replaces normal film-holders on 5 x 7 and 8 x 10 cameras with a roll

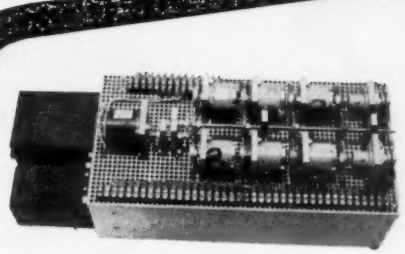


of 350-exposure daylight-loading 70-mm. film. It is mounted on camera in place of ground-glass. Counter registers number of exposures.—*Korona Camera Works, Div. Gundlach Mfg. Co., Fairport (Rochester), N. Y.*

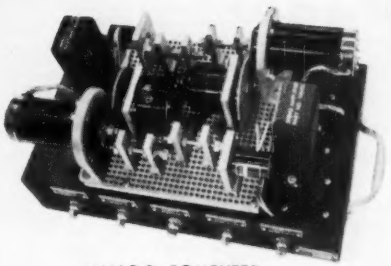
For more information circle **268** on inquiry card.

Microscope Attachment for Photomicrography

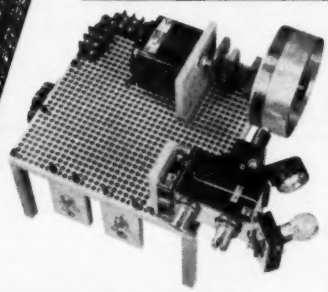
New "Microflex" attachment for 35mm. photomicrography is furnished with camera mount to accommodate either Nikon and Contax or Leica and



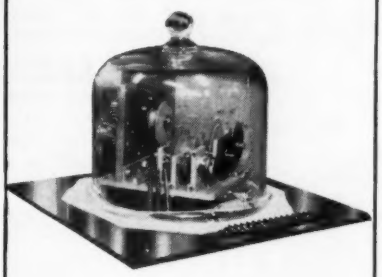
REMOTE CONTROL



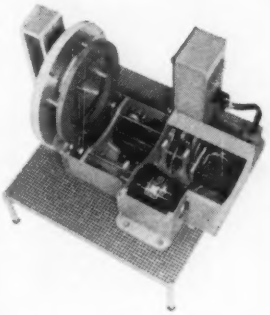
ANALOG COMPUTER



TEST EQUIPMENT



INSTRUMENT BREADBOARD



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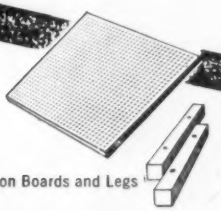
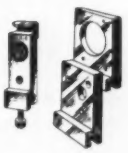
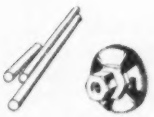


Foundation Boards and Legs



Mounting and Bearing Blocks



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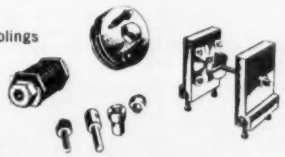

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For more information circle **61** on inquiry card.

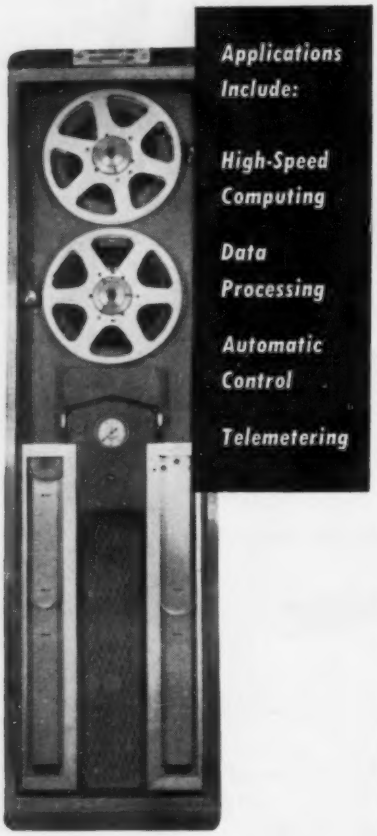
ElectroData

Corporation announces

DataReader

Model 546

A transport unit for high speed searching, reading and recording of data on magnetic tape.



PERFORMANCE:

RAPID START—STOP—REVERSE—from stop to full speed in 6 milliseconds.

HIGH TAPE SPEED—optional speed of 30, 40, 50, 60 or 75 in/sec.

TWO-DIRECTION SEARCH—either direction, automatically at full speed.

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For more information circle **62** on inquiry card.

NEW INSTRUMENTS

Canon cameras; mounts are interchangeable. Among features: Fits all standard microscope tubes; shutter speeds from 1 sec. to 1/200th, T & B; 45-deg. prism reflects micro-image into focusing-viewing ocular tube.—*Nikon Inc.*, 277 *Fifth Ave., New York* 16, *N. Y.*

For more information circle **269** on inquiry card.

35-mm. Strip Printer

New "Diafix 35" is for both perforated 35-mm. paper prints and perforated 35-mm. film positives. Exposure is made in darkroom under an enlarger light.—*Burke and James, Inc.*, 321 *S. Wabash Ave., Chicago* 4, *Ill.*

For more information circle **270** on inquiry card.

LABORATORY

Micro Pipet Buret

New 10-ml. size of "Gilmont Micro Pipet Buret" is announced; also parts to convert 0.1 or 1 ml. size "Micro Pipet Burets" to new 10-ml. size.—*Emil Greiner Co.*, 20-26 *North Moore Street, New York* 13, *N. Y.*

For more information circle **271** on inquiry card.

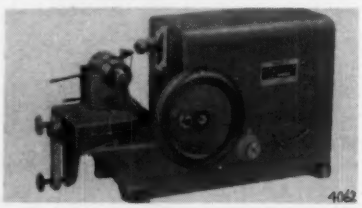
Lab Manometers

New design of maker's single-rod "Double-Capillary" manometer features easy and accurate reading, individually calibration before shipment. Four models: "30-20" for Warburg apparatus, with 30-cm. scale graduated in mm.; "5-20" same except neck length; "30-22" is a differential manometer; and "30-24" is double-capillary "Summerson Constant Volume Differential Manometer."—*Bronwill Scientific, Inc.*, 131 *Gould St., Rochester* 7, *N. Y.*

For more information circle **272** on inquiry card.

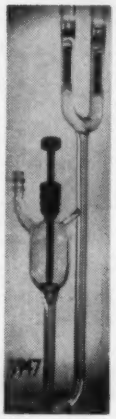
Microtome

New "Servall Porter-Blum Microtome" (formerly called "Cantilever Action Microtome") is for ultra-thin sectioning required in electron microscopy: sections from 1/40 to ½ micron of exceptional quality and uniformity. Older model's basic design has been strengthened and important new features have been added.—*Ivan Sorvall, P. O. Box* 230, *Norwalk, Conn.*



For more information circle **273** on inquiry card.

Mercury-sealed Valve

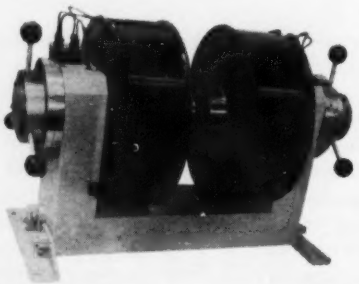


New "Delmar-Urry Greaseless Type Stock Valve" was designed to be free from disadvantage of conventional types incorporating a lubricated stopcock to control flow of mercury (grease in float U-tube a major source of valve failure). New design replaces lubricated stopcock with a mercury-sealed needle valve in mercury reservoir, that screws down onto a ground glass set: easily operated, always grease-free.—*Dept. G. S., Delmar Scientific Labs.*, 1551 *N. Cicero Ave., Chicago* 51, *Ill.*

For more information circle **274** on inquiry card.

Laboratory Electromagnet

New "V-4004 laboratory electromagnet embodies "the most convenient features for varying magnetic field configurations": two fixed energizing coils with adjustable poles and readily-changeable pole caps; air gap width up to 4.3 in.; gap field flux density up to 28,600 gauss.—*Special Products Div., Varian Associates*, 611 *Hansen Way, Palo Alto, Calif.*



For more information circle **275** on inquiry card.

Temperature Control for Ultracentrifuge Rotors

New temperature-measurement and control system makes possible continuous indication and automatic control

EPLAB

Thermopiles

For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

*Vandaveer, Industrial & Engineering Chemistry, Vol. 22, page 596, June 1930.

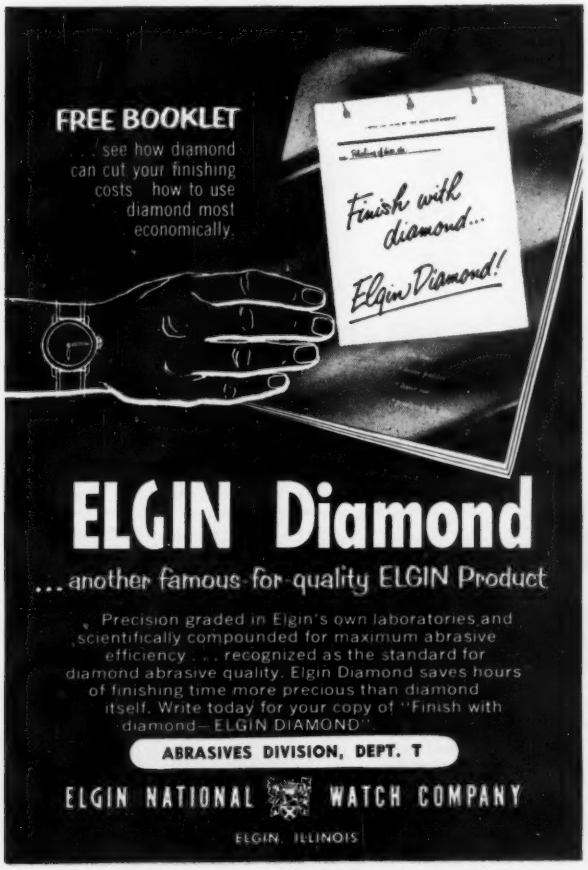
BULLETIN No. 3 ON REQUEST—Address: 2 Sheffield Ave., Newport, R. I.

THE EPPLEY LABORATORY, INC.

SCIENTIFIC INSTRUMENTS

NEWPORT, RHODE ISLAND, U. S. A.

For more information circle **63** on inquiry card.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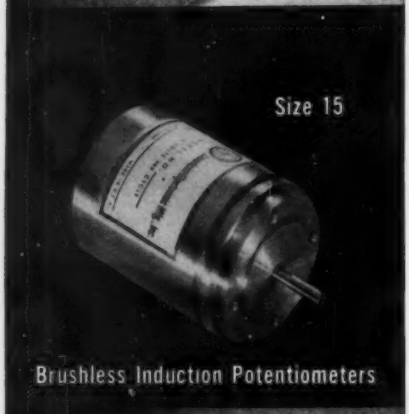

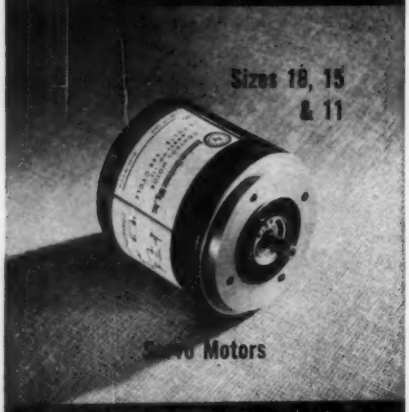

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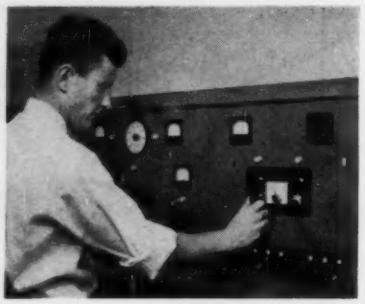
For more information circle **66** on inquiry card.

NEW INSTRUMENTS



of temperature of operating ultracentrifuge rotors to better than 0.1 C. degree; is applicable to any "Model E Analytical Ultracentrifuge."—*Specialized Instruments Corp.*, 6550 *O'Neill Ave., Belmont, Calif.*

For more information circle **276** on inquiry card.

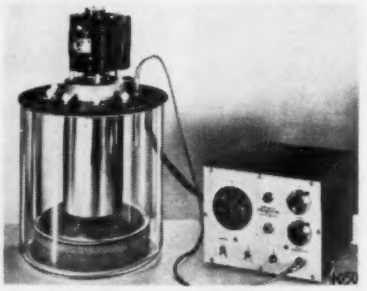
Variable-voltage Supply

New "Model 1904" variable-voltage d-c. power supply, designed especially for clinical electrophoresis units but applicable to other laboratory uses, delivers direct voltages continuously variable between 0 and 450 to meet needs of labs which do not require voltage regulation. Dimensions 5x9x6 in.—*Research Specialties Co.*, 1148 *Walnut St., Berkeley 7, Calif.*

For more information circle **277** on inquiry card.

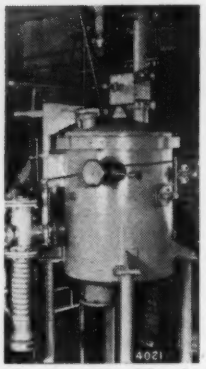
Viscosimeter Bath

New "S-67428" incorporates "Model SV Thermonitor" for controlling bath temperature; is recommended for use with Ostwald viscosimeters in accordance with ASTM method D-445; produces accuracy of regulation to approx. 0.02 F. deg. "Thermonitor" has a work range of 0 to 100 deg. C. and an operating sensitivity of 0.01 C. deg. —*E. H. Sargent & Co.*, 4647 *W. Foster Ave., Chicago* 30, *Ill.*



For more information circle **278** on inquiry card.

Vacuum Furnace



New 30-lb. self-contained induction-heated vacuum furnace for research and development, is offered with vertical or horizontal shell; features coaxial power feedthrough and means for adding additional charge or alloying material during melting without losing vacuum. — *Naresco Equipment Corp.*, 160 *Charlemont St., Newton Highlands* 61, *Mass.*

For more information circle **279** on inquiry card.

Microscope Illuminator

New "Ortho-Illuminator B" converts any standard microscope into an integrated unit with a built-in light source employing Koehler principle, for use in visual microscopy or with existing

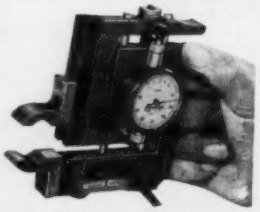
photomicrography equipment.—*Silge & Kuhne, 16th & Carolina Sts., San Francisco* 19, *Calif.*

For more information circle **280** on inquiry card.

DIMENSIONAL GAGING and INSPECTION

Dial Gage

New "Versa-Dial" checks internal or external threads, grooves, shallow counterbores, narrow shoulders, etc.

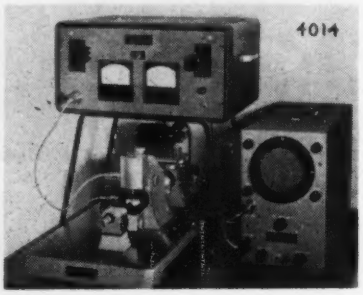


Interchangeable segments for contacting work surfaces to be measured are secured in "T" slots at desired spacing. User may select segments from stock types, or have special ones made.—*Standard Gage Co., Inc., Poughkeepsie, N. Y.*

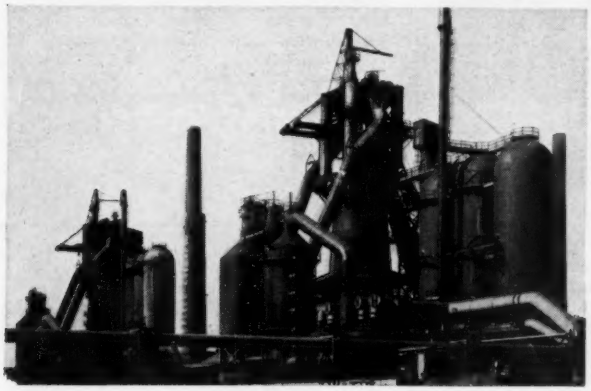
For more information circle **281** on inquiry card.

Waviness Meter

New "Ball Wavometer" for measuring waviness of balls from 1/16 to 1¼-in. diam. shows r.m.s. average height of irregularities for each of two wave-bands; full-scale readings 1, 3, 10, 30, 100 and 300 microinches. Option: oscilloscope to show general



CAMBRIDGE
TOP GAS ANALYZERS



MAKE YOUR FURNACE MORE EFFICIENT

The Cambridge Gas Analyzer gives continuous and simultaneous records of CO_2, H_2 and CO in blast furnace top gases. The instrument helps the operator to maintain a thermal balance and to identify the approach of a channelling or hanging furnace. The analyzer's alarm system assures early warning of water leaks or a cut tuyers.

The analyzer is accurate, sensitive and ruggedly built for steel mill use. The instrument is automatic in operation and requires only routine attention.

Use of the Cambridge Top Gas Analyzer makes possible greater uniformity of operation and product.

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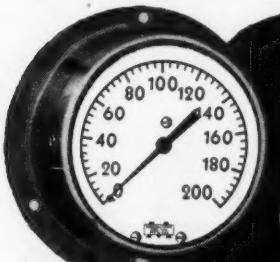
For more information circle **67** on inquiry card.



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For more information circle **68** on inquiry card.

NOW...a HATHAWAY
Strain Indicator

with these advantages:

One Dial Indication
Balancing Controls
Highly Accurate
Portable
Multi-Channel

The Hathaway Type RS-20 Portable Strain Indicator is a new and improved instrument for use both in the field and in the laboratory. It is designed specially for use with type SR-4 resistance strain gages of 120 ohms resistance, but may be used with any type of resistance strain gage or with various other kinds of carrier-excited transducers.

CHECK THESE FEATURES

- **Strain is read directly in microinches-per-inch from one dial**
- **Resistance and capacitance balancing controls**
- **Battery or a-c operation with no accessories**
- **Gage factor control**
- **Accuracy to within 1 microinch-per-inch**
- **Range to 20,000 microinches**
- **Available in 2, 6 or 12 channels**
- **Portability gained through the use of very rugged construction**
- **Advanced circuit design**
- **Records with oscilloscope or galvanometer oscillograph using available accessories**

Hathaway INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO
DIVISION OF HAMILTON WATCH COMPANY

Please send me your Bulletin 3H5-H on Hathaway Type RS-20 Portable Strain Indicator.

Name.....

Firm.....

Address.....City.....State.....

For more information circle **69** on inquiry card.

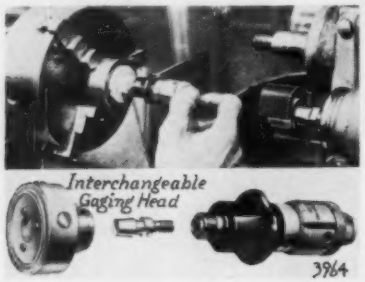
NEW INSTRUMENTS

shape, spacing, and approx. number of waves in either wave-band.—*Micrometrical Development Corp.*, 2821 *S. State St., Ann Arbor, Mich.*

For more information circle **282** on inquiry card.

Internal Micrometer

New "Matrix Micro-Maag Internal Micrometer" determines bore sizes, ¼-in. to 8-in., features irregular spacing of gaging pins (anvils) to detect most

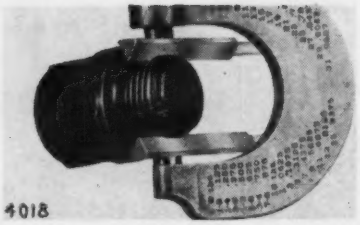


forms of out-of-roundness—not possible with even spacing. Thimble which actuates taper needle is controlled by a spring which insures repetition of measurement.—Distributed in U. S. by *Engis Equipment Co.*, 431 *S. Dearborn St., Chicago* 5, *Ill.*

For more information circle **283** on inquiry card.

Thread Triangles

New "Thread Triangle Gauges" obviate cumbersome calculating; are used for all threads, whether standard or non-standard. Micrometer reading



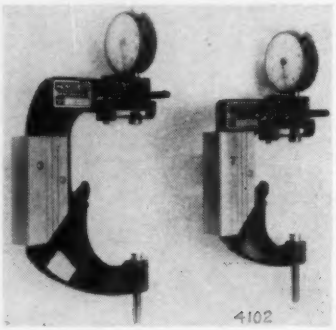
is checked against sum of nominal OD of thread and chart factor. Triangles give full-bearing line contact on whole of thread V, instead of point contact as with wires; hence more accurate "feel" on micrometer.—*Montgomery Tool Sales, Box* 1241 *Church Street P.O., New York* 7, *N. Y.*

For more information circle **284** on inquiry card.

Hand Snap Gages

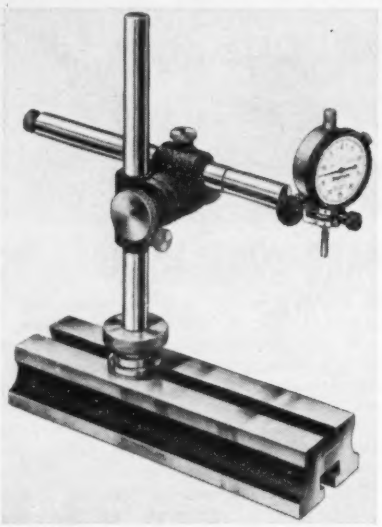
New "Model SGA" have built-in 0.010 range fine adjustment to facilitate setup and keep indicator hand at ideal position of 12 o'clock while gaging. Backstop at 45 deg. provides a stop position always on center for full range of gage. Nine standard sizes up to 14 in. Also available: bench stand converting gage to a high production comparator.—*Acra-ment Gage Div., Myer Corp., Park Ave., Cranston, R. I.*

For more information circle **285** on inquiry card.



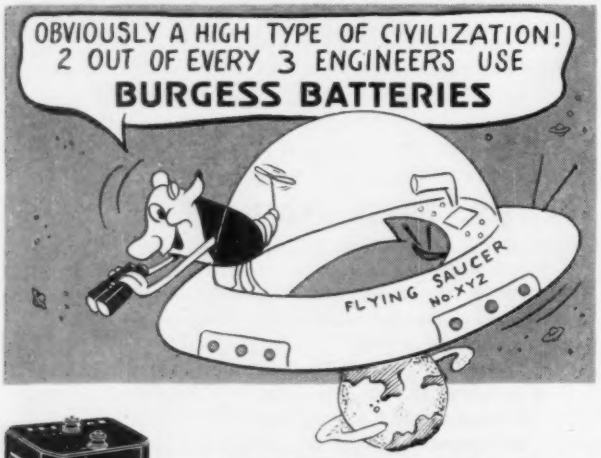
Dial Test Indicator

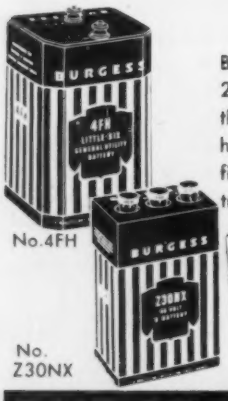
New "No. 675 Heavy Duty Dial Test Indicator" features extreme rigidity



plus universal adjustment to any position.—*The L. S. Starrett Co., Athol, Mass.*

For more information circle **286** on inquiry card.





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For more information circle **70** on inquiry card.

STOP TRACING AIR LINES install
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Hankison Dehydrafilter - simple in design and operation, removes vapors from compressed gases serving one or two instruments or controls . . . it eliminates costly tracing of Air Lines with Steam or Electricity since dew points of -67° F. are obtainable . . . write for BULLETIN C - 5154.

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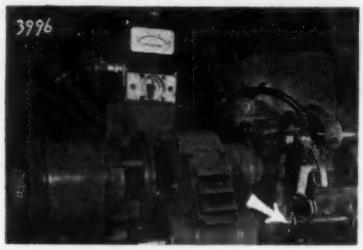
352 Biltmore Bldg., 951 Banksville Rd., Pittsburgh 16, Pa.

For more information circle **71** on inquiry card.

MACHINE AUTOMATION

Dimensional Controller

New "Electro Autosizing Device" can control automatically a grinding machine's cycle and guarantee tolerances as low as 0.00005 in. on size, taper and form (all indicated on dial).

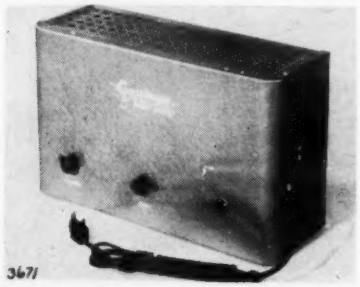


When piece is down to size, wheel retracts automatically. "Autosizer" is self-compensating for wear, temperature and moisture changes; can be adapted to almost any machine.—*Industrial Gauges Corp., Englewood, N. J.*

For more information circle **287** on inquiry card.

Proximity-type Machine Safety Shut-off

New "Model TGS 150 Silent Sentry" will stop or change a machine or operation immediately if a person moves

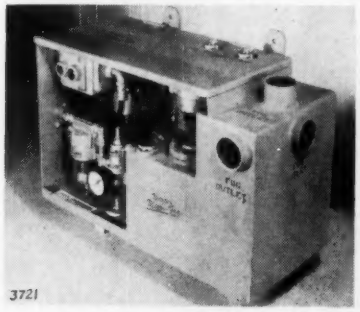


into protected area. Sensitivity can be adjusted so that a body approaching to within 12 in. of pick-up plate will actuate device, whose contacts will handle a non-inductive load of 5 amp. 117 v.a.c.—*R. G. Genzlinger, Inc., Neshaminy, Pa.*

For more information circle **288** on inquiry card.

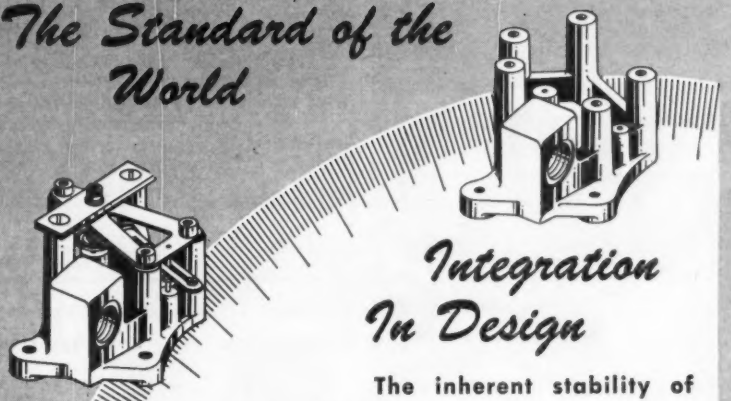
Automatic Lubricator

New 4½-gal. oil capacity bearing lubrication unit of oil fog type serves remote lubrication points with up to 1000 bearing inches. Automatic system provides warning signals or other safeguards against depletion of oil supply, failure of air supply, excessive pressure in oil supply tank. Fog



HEISE GAUGES

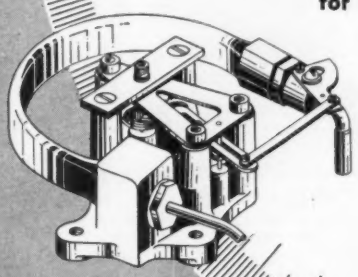
The Standard of the World

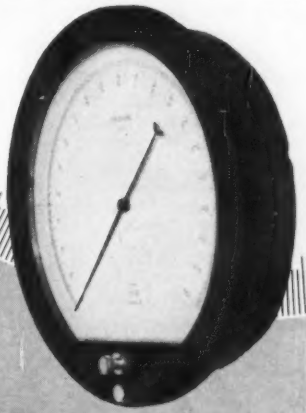


Integration In Design

The inherent stability of the Heise Gauge movement and the elimination of significant hysteresis effect in the integrally mounted Bourdon Tube give the Heise Gauge its ability to indicate faithfully the most minute pressure variations. The scientific design of the Heise Bourdon Tube section and its weldless construction from carefully selected and heat treated metals is an exclusive Heise feature.

Custom designed to meet your specific needs, this gauge will register precisely for liquids, gases or mercury. Convenient adjustment of the dial may be used to compensate for barometric changes.





Pressure Ranges
15 to 20,000 P.S.I.

DIAL SIZES
8½" — 12" — 16"

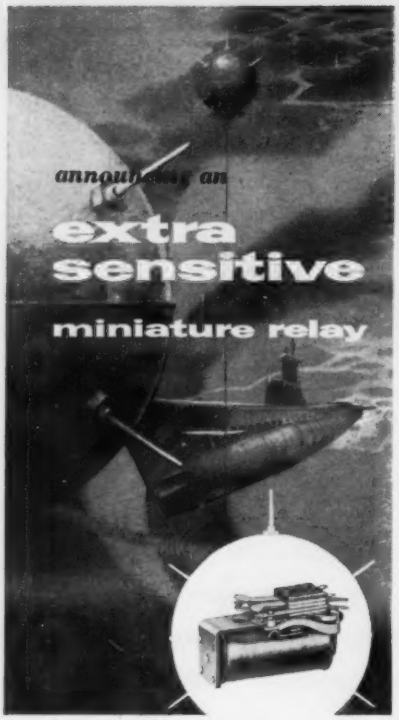
PRICES
from $151.60

DELIVERY
within 30 days

Catalog on Request

HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **72** on inquiry card.



It's the new ADVANCE SQ—a telephone type that hits a new high in ruggedness and efficiency!

Only 15 milliwatts per pole will operate the new SQ relay in the DPDT combination. Here is sensitivity teamed with stable performance—the DPDT unit withstands 10 G's vibration from 10 to 500 cycles. When power is increased to 40 milliwatts per pole, vibration resistance rises to 30 G's. A single-coil relay, the ADVANCE SQ is available in 1- to 5-amp contact ratings, and in contact combinations from SPST to 6PDT. It comes through Signal Corps tumbling and shock tests in excess of 200 G's with operating characteristics unimpaired.

Sustained efficiency keynotes SQ operation. The use of a beryllium copper armature retaining spring insures positive contact between armature and pivot points at all times. Cross-bar palladium contacts are always properly aligned. A wide variety of coil resistances is feasible. Instead of organic insulation, the unit employs Silicone glass, Kel-F, or Teflon tubing. Life expectancy for 5-amp, non-inductive loads is 150,000 cycles... for 1-amp, non-inductive load: 1,000,000 cycles.

Open type dimensions are 1" x ¾" x 1⅝". DPDT units are supplied in a sealed container measuring 1" x 1" x 2". Write for literature on the SQ series.

ADVANCE ELECTRIC AND RELAY CO.
2435-H NORTH NAOMI ST.
BURBANK, CALIFORNIA

Sales Representatives in Principal Cities of U. S. and Canada

For more information circle **73** on inquiry card.

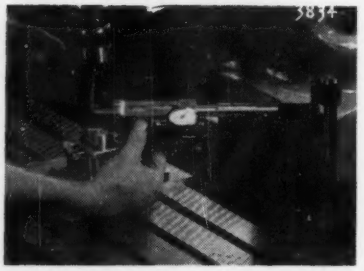
NEW INSTRUMENTS

delivery automatically starts and stops in coordination with machine operation.—*C. A. Norgren Co., 3400 S. Elati St., Englewood, Colorado.*

For more information circle **289** on inquiry card.

Tool Position Indicator

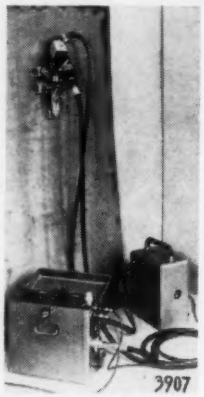
New indicating device enables setting boring cutters to within 0.00025 in. of desired cutting position in a few seconds' time; consists of a micrometer-spindle and dial-indicator combination mounted at end of an extention bar pivoted from a bracket attached to machine frame; is permanently referenced at zero in respect to spindle axis of the jig borer or other machine on which it is installed.—*Euclid Instrument Co., 743 232nd St., Cleveland 23, Ohio.*



For more information circle **290** on inquiry card.

MECHANICAL TESTING

X-ray Diffraction Type Stress Analyzer



New "Androscope," said to be the first portable stress analyzer using x-ray diffraction method available for field and plant operations, measures magnitude and sense of residual stresses in metals, plastics, etc.; is easily operated.—*Holger Andreasen, Inc., 703 Market St., San Francisco 3, Calif.*

For more information circle **291** on inquiry card.

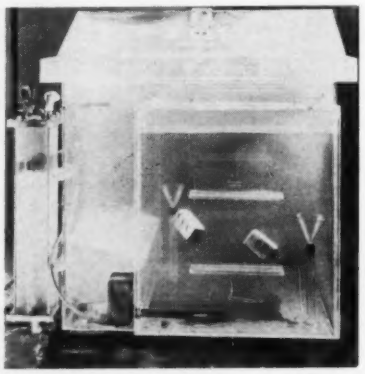
Surface Tension Tester

New "Jiffy Loop" pocket-size tester is for making surface tension measurements under production conditions, by immersing loop end into solution, swishing around a few seconds, then slowly withdrawing vertically: condition of film indicates surface tension and determines amount of wetting agent in solution. Several standard sizes. Convenient pocket carrying case.—*Pollack Products Co., 1628 E. 7th St., Brooklyn 30, N. Y.*

For more information circle **292** on inquiry card.

Corrosion Test Cabinet

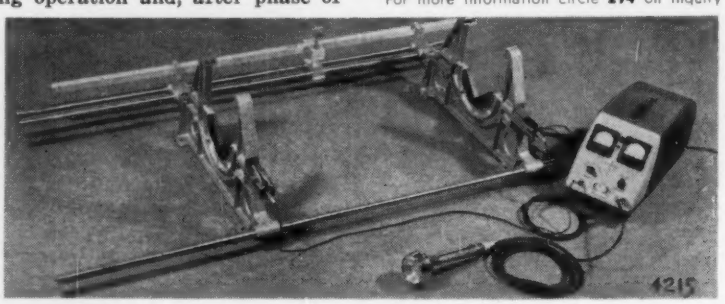
New redesigned "Singleton H-T Sincolite" test cabinet features "picture-window" visibility during tests; insulating effect of flat-panel "H-T Sincolite" water-jackets housing two new electric heaters located front and rear on outside of cabinet, said to offer a special advantage in short tests of black oxide finishes and other less-protective coatings.—*The G. S. Equipment Co., 5317 St. Clair Ave., Cleveland 3, Ohio.*



For more information circle **293** on inquiry card.

Dynamic Balancer

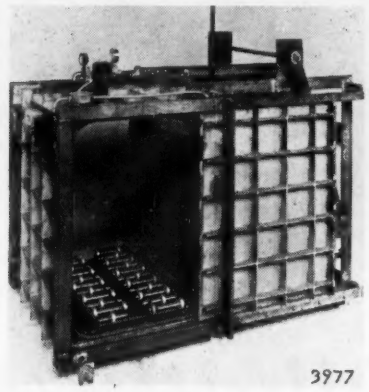
New dynamic balance stand balances armatures, etc., to vibration tolerances as fine as 0.00025 in.; features mechanical plane separation to eliminate cross effect of imbalance. Suspended saddle assembly is locked at each correction plane during balancing operation and, after phase of imbalance is established, only one run at each end of a rotor is usually required. Capacity of 30 to 500 lbs., parts up to 24 in. diam. and 51 in. long.—*International Research & Development Corp., Box 1707, Columbus 16, Ohio.*



For more information circle **294** on inquiry card.

Pressure Chamber

New pressurizing and impregnating chamber is for pressure testing of tubes and other components, in their cartons, gaseous impregnation, etc.

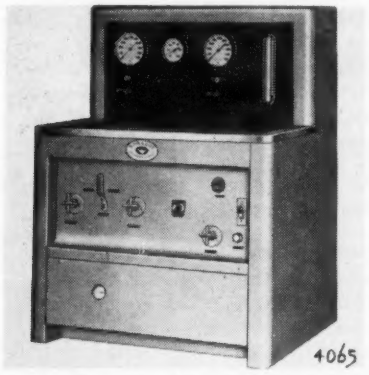


Two push buttons control complete operations. Unit meets ASME and State codes, is National Board Approved.—*Glasco Equipment Corp., 12 Wait St., Paterson, N. J.*

For more information circle **295** on inquiry card.

Hydraulic Test Stand

New "Model S-1000-6C3" operates at pressures to 3000 psi. and flow-

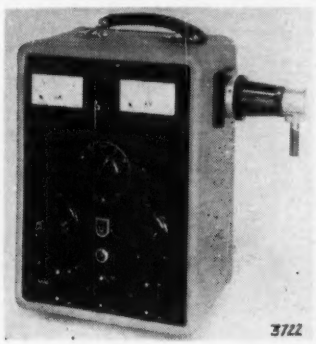


rates to 6 gpm.; is low in cost but retains features found in maker's larger units.—*Sprague Engineering Corp., Gardena, Calif.*

For more information circle **296** on inquiry card.

Microradiograph

New "Type CMR5" 5-kv contact microradiograph unit utilizes a new miniature x-ray tube with an extremely thin beryllium window; brings specimen into close contact with a photographic emulsion having high resolving power. Tiny x-ray photograph

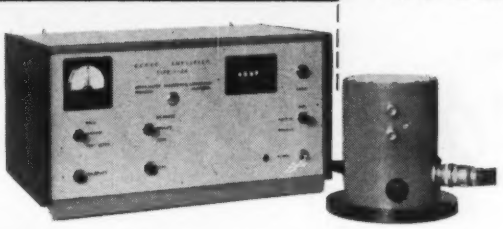


Tired of eye strain?

Eliminate tedious manometer tube readings from your operations *now!* CEC's *all-electronic* 37-103 Electromanometer equals the mercury manometer in accuracy (0.05% of full scale) and gives you many important advantages. Whenever a fast, accurate pressure standard is required, investigate this new method of pressure measurement . . . send for Bulletin CEC 1547-X1.

- fast response time
- rugged, compact, fully portable
- two readouts: visual digital and 10 volts analog output
- negligible temperature effect
- remote operation: measurements can be telemetered, digitized, recorded
- little maintenance required

CEC 37-103 Electromanometer



37-103 Electromanometer . . . interchangeable pressure heads (right) are offered in 5, 15, 60 and 150 psi ranges, can measure gage, differential or absolute.

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For more information circle **74** on inquiry card.

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. . . easy to learn

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The kit contains 82 precision components, everything you need to perform 60 experiments. A correlated, 275-page work manual shows you in words and pictures exactly how to proceed.

Model 50-A complements Crow Electri-Kit Model 41-B . . . takes you from Beginners' Electricity directly into the study of Electronics. With this unique kit, anyone familiar with basic electrical principles can learn electronics easily. It can even be used for self instruction at home . . . as fascinating as your favorite hobby.

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Filters • Electrical Indicating Instruments
Rectifiers • Resonant Circuits • many more

Price of the complete, 82-piece Model 50-A kit—including precision meter (±1%), resistors, coils, capacitor bank, etc.—is $87.50. Write for illustrated folder giving full details.

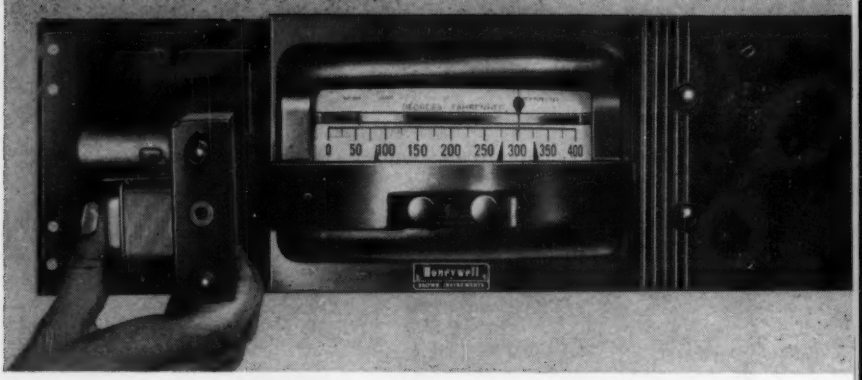
Model 50-A Kit provides a solid foundation for further training in specialized electronic fields—Radio Transmitting and Receiving, Industrial Electronic Circuitry, or Radar and Television Circuitry.

These principles are covered in the Crow Electronic Tubes, Circuits and Devices Kit (Model 53) available soon.

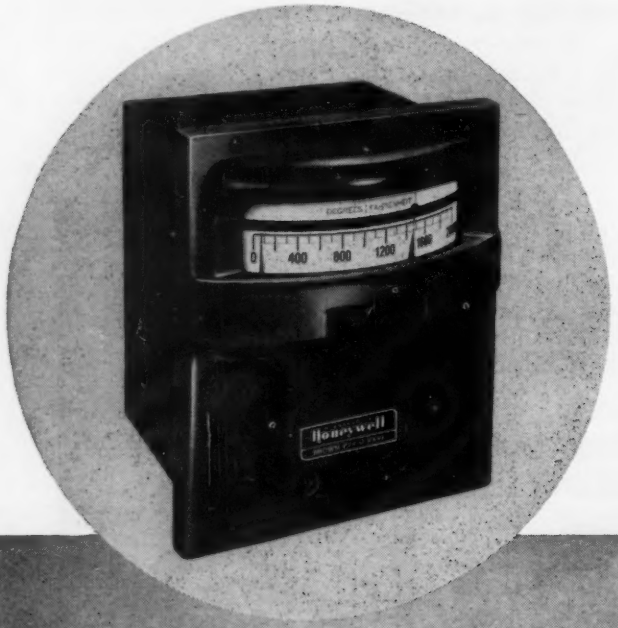
CROW ELECTRI-CRAFT CORP.

Division of Universal Scientific Co., Inc.
Box 338W, Vincennes, Indiana

For more information circle **75** on inquiry card.



For reliable, economical

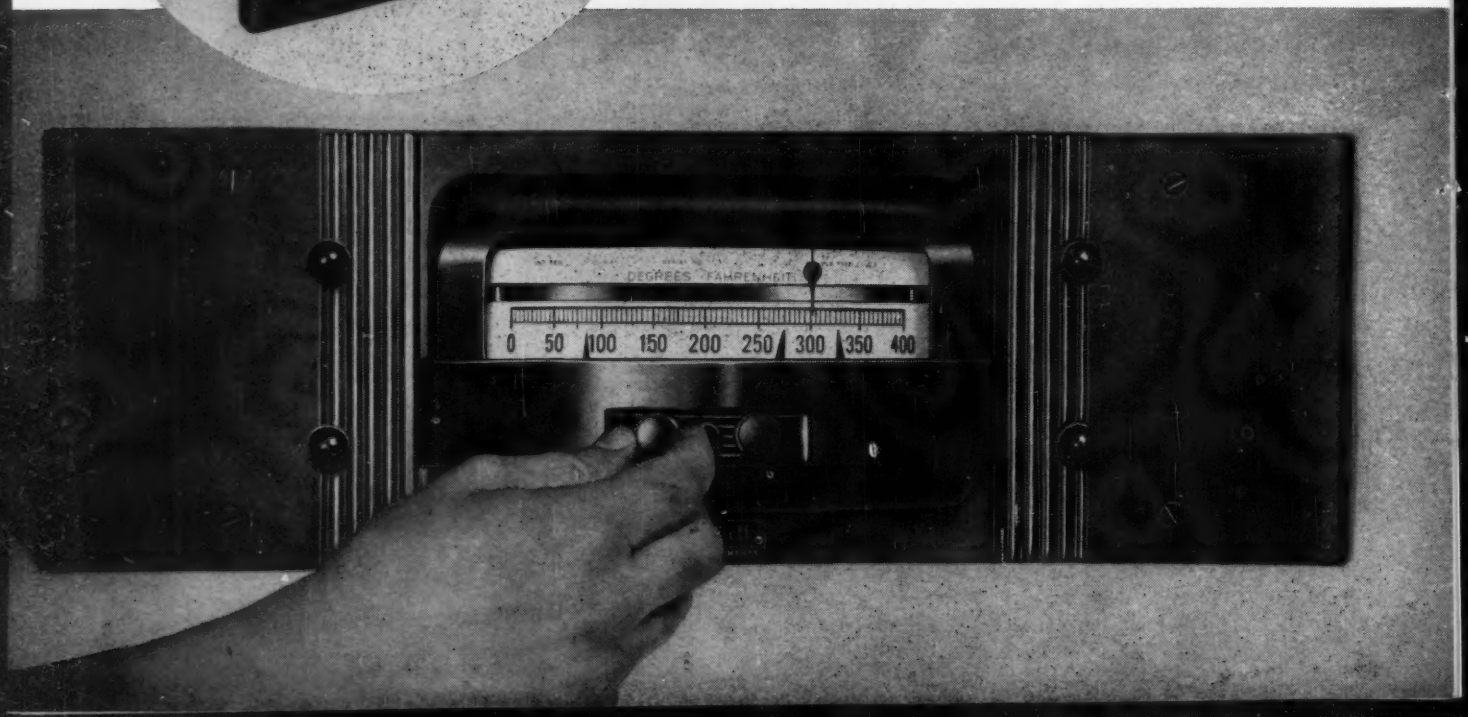


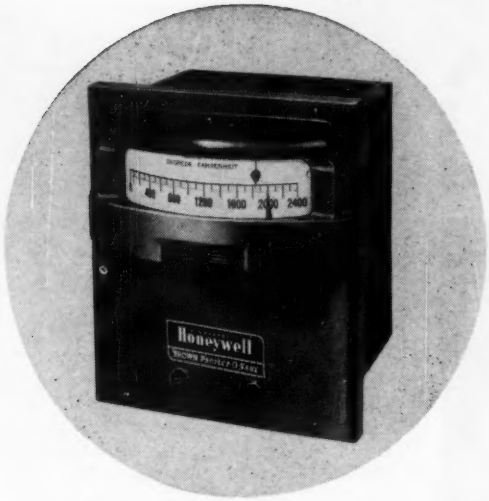
Pyr-O-Vane Controllers

Horizontal-case model fits standard 19″ relay racks. Available in a choice of control actions, including three-zone control with neutral zone adjustable from 0 to 100%, or 0 to 10%. Pre-wired panel permits checking of thermocouple or millivoltmeter without disconnecting wiring.

Vertical-case model can be flush or surface mounted.

Both types are available with "snap action" electronic vane control; on-off, two-position and three-position; and with pulse-type time-proportioning control. They are designed for fail-safe operation, and are virtually unaffected by changes in line voltage, humidity and temperature. Supplied with either thermocouple or *Radiamatic*® calibrations.





Protect-O-Vane Excess Temperature Safety Cut-Off

Now available in both horizontal- and vertical-case models, *Protect-O-Vane* instruments afford economical insurance against overheat damage to expensive furnaces. They operate in conjunction with primary controllers . . . which may be either *Pyr-O-Vane* models or recording instruments . . . to close the fuel valve or open electric heating circuits whenever the safe temperature limit is exceeded. At the same time, they can actuate signal lights or audible alarms. Their safety circuit prevents re-starting the process until temperature has dropped below the safe limit.

temperature control...

BROWN MILLIVOLTMETER CONTROLLERS

LOOKING for versatile, dependable, economical control? Then choose from the line of Brown millivoltmeter controllers. This varied family of instruments fills the requirements of hundreds of temperature control applications where a chart record is not essential. On ovens, dryers, furnaces, plating tanks, plastic presses and other heat-using equipment, they bring sensitive, reliable control within the reach of any budget.

Built into these instruments are numerous advanced design features. Both *Pyr-O-Vane* Controllers and *Protect-O-Vane* Safety Cut-Offs have a high-resistance galvanometer circuit that minimizes effects of varying length of extension wires . . . 6-inch scale with anti-parallax mirror . . . readily accessible zero adjustment. Plug-in galvanometer and control units reduce replacement time to seconds.

Both the *Pyr-O-Vane* and *Protect-O-Vane* types of instruments are now available in two case styles: the conventional vertical case, to fit installations where width is restricted; and the new horizontal case, which takes only a few inches of vertical mounting space.

Behind all these instruments stands more than 90 years of experience with millivoltmeter instrumentation . . . plus the nation-wide engineering and field service facilities of the Honeywell organization. For a discussion on how these economical controllers can be put to work on your processes or on the equipment you manufacture, call your local Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Catalog 1053, "Millivoltmeter Type Instruments" . . . and for Bulletin 1060, "Horizontal Case Millivoltmeter Controllers."

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

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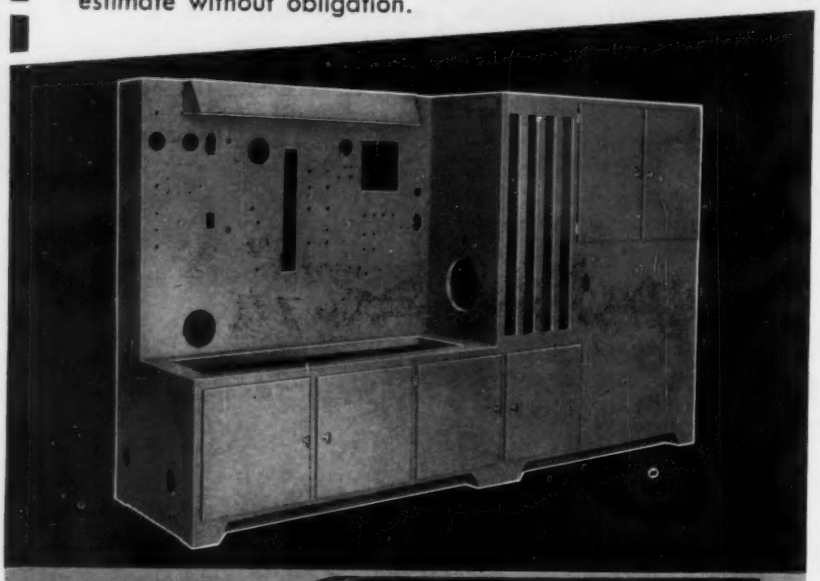
Is size, accuracy, delivery or price *your* problem? Then be sure to have Littleford fabricate your cabinet, cubicle or control panel. Mail us your blueprint for prompt estimate without obligation.



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For more information circle **77** on inquiry card.

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For more information circle **78** on inquiry card.

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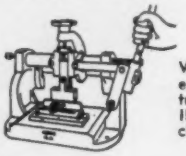

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For more information circle **79** on inquiry card.

NEW INSTRUMENTS

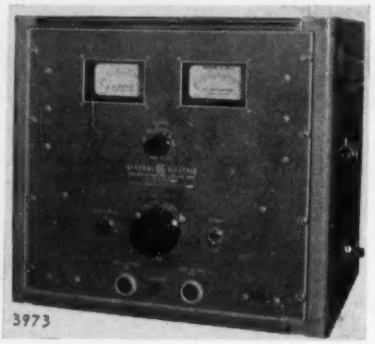
is optically magnified by means of a light-microscope and negative thus obtained is enlarged to desired size by normal photographic procedures. Useful magnification of 500 times, and 0.5-micron resolution.—*North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.*

For more information circle **297** on inquiry card.

ELECTRICAL TESTING

Insulation Tester

New 10-kv. insulation resistance meter measures degrees of insulation resistance, polarization index, and



leakage current; provides for making d-c. over potential tests; measures resistances up to 200,000 megohms at 10 kw.—*Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **298** on inquiry card.

Inductance Comparator

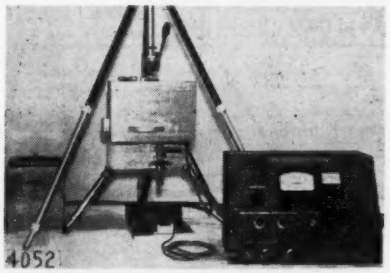
New "Type 1870 Incremental Inductance Comparison Bridge," for rapid testing of transformers and

chokes under operating conditions, comprises a variable 0-500-ma. dc. supply, an ac. supply, a comparison circuit and a VTVM. Inductances of 25 mh. to 25 hy can be compared. —*Freed Transformer Co., Inc., 1715 Weirfield St., Brooklyn 27, N. Y.*

For more information circle **299** on inquiry card.

Semiconductor Tester

New "Model GL-131" test set was developed for separate measurement of bulk lifetime of minority carriers and surface recombination velocity constant of germanium and other semi-conductors in production quantities. Operation is based on photomagnetoelectric effect in semi-conductors. Entire system is controlled from cabinet which contains phase-sensitive voltmeter and current source. Direct

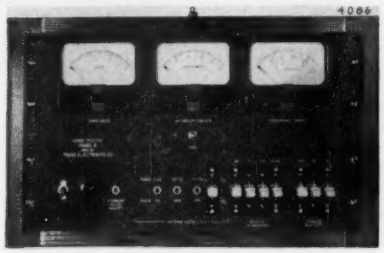


measurements are made by a single adjustment of measuring circuit and indicator deflection. "GL-131" is especially suitable for large-scale production lines.—*Scientific Specialties Corp., Moston 35, Mass.*

For more information circle **300** on inquiry card.

Diode Tester

New "Model B" measures d-c. characteristics of diodes in both forward and reverse directions. Voltage sup-

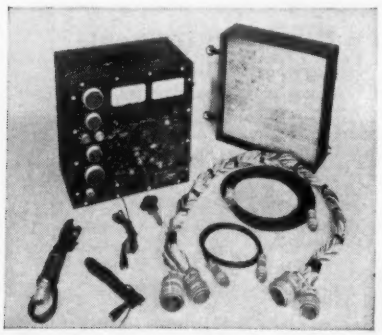


plies, E_1, E_2, and E_3, preset from 0-25, 25-75 and 75-150 volts respectively, are available for measuring reverse currents. Forward voltage supply preset from 0.1 to 2.5 v. Voltage monitoring ranges 0-3, 0-30 and 0-300. All range and scale selection automatically taken care of in switching.—*Trans Electronics Co., 7243 Eton Avenue, Canoga Park, Calif.*

For more information circle **301** on inquiry card.

Cable Harness Tester

New "Model HC" permits complete testing of cable harnesses (continuity, insulation resistance, dielectric strength, and use of external instru-



ments) in production or as a maintenance check.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **302** on inquiry card.

Automatic Cable Tester

New "Model M-94 Automatic Continuity Tester" is for use with cable harness assembly boards during manufacture or with plug-in cable test fixtures. Each unit checks 100 circuits in

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FLIGHT TEST

FLIGHT TEST ENGINEERS skilled in operations, analysis, telemetering and oscillographic instrumentation are offered unusual career opportunities now at Convair in beautiful San Diego, California. If you are experienced in experimental flight testing, either airplane or missile, Convair invites your inquiry at once! Opportunities exist in the areas of power plant, flight characteristics, flight controls, performance and field testing. In the Convair Engineering Department you will join in the experimental development and testing of missiles, commercial aircraft and military land and water based aircraft.

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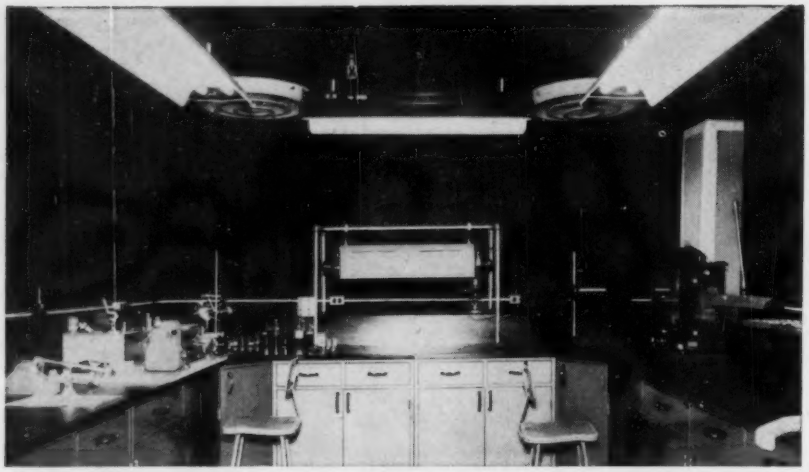

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Niagara Air Conditioning provides you with any temperature and relative humidity you need, held constant or varied at will. Using "Hygrol" absorbent, you save the refrigeration commonly used to condense moisture and make reheat unnecessary in most cases. It gives large capacity with compact, easily-maintained equipment.

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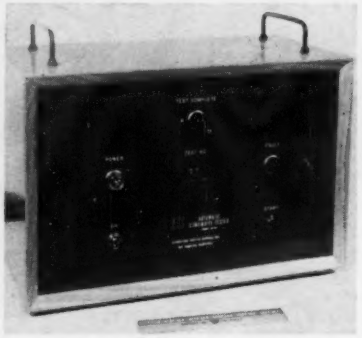
For more information circle **80** on inquiry card.

NEW INSTRUMENTS

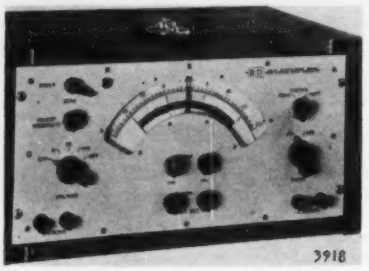


12 seconds, any number of units can be used in parallel. Unit is self-sequencing, red warning light indicates fault, and counter register shows number of open circuit.—*Electronic Control Systems, Inc.*, 2138 *Westwood Blvd., Los Angeles* 25, *Calif.*

For more information circle **303** on inquiry card.

Deviation Bridge

New "Type 38" serves either as resistor comparator with operator placing resistors in bin indicated, or as



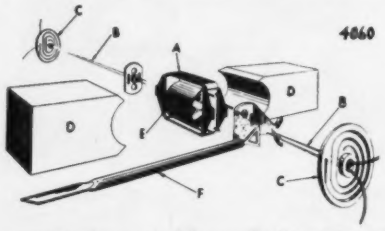
semi-automatic sorter with 3000 resistors binned per hour. Range 10 ohms to 100 megohms. Accuracy 0.5 percent of full-scale.—*Barnes Development Co.*, 213 *W. Baltimore Pike, Landsdowne, Penna.*

For more information circle **304** on inquiry card.

ELECTRICAL INSTRUMENTS

Bifilar Instruments

New "Simpson-Greibach" instrument movement features armature held in place by fine bifilar wires kept under tension by disc springs contained in adjustable end pieces of



movement cartridge. Laboratory standards constructed by this principle are said to have been "shock tested to 500 *G* without appreciable loss of accuracy." Initially, new movement will be supplied in custom-built instruments and in high-precision high-shock laboratory instruments.—*Simpson Electric Co.*, 5200 *W. Kinzie St., Chicago* 44, *Ill.*

For more information circle **305** on inquiry card.

D-c. VTVMs

New "Models 200 and 200A Electrometers" are battery-operated d-c. vacuum-tube voltmeters with input impedances exceeding 10^{14} ohms. Output terminals provide a convenient means for recording an extremely broad range of voltages (2-20,000), currents (down to 2×10^{-12} amp.) and resistances (10^{14} ohms) with accessories; and amplifier-recorder systems can be given an inexpensive ultrahigh input.—*Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio.*

For more information circle **306** on inquiry card.

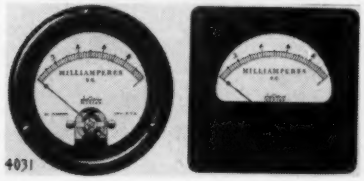
Volt-Ohm-Milliammeter

New "Model 980" has d-c. sensitivity of 20,000 ohms/volt and a-c. sensitivity of 1,000 ohms/volt; features single dial for all ranges and functions. Ranges: 1.6, 8, 40, 160, 400, 1600 v.dc.; 1.6, 8, 40, 160, 400, 1600 v.ac.; –15 db to +54 db (in six ranges); 80 ua.dc.; 8, 80, 800 ma.dc.; 8 a.dc.; 25 ohms to 10 megohms.—*Weston Electrical Instrument Corp., Newark, N. J.*

For more information circle **307** on inquiry card.

Custom Instruments

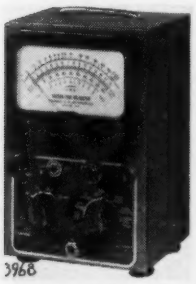
New "Custom Instruments" are anti-magnetic, are available in 2½-in. and 3½-in. sizes; incorporate most ruggedized features demanded by



MIL-M-10304; are modified for industrial use. Permanent accuracy is 2 percent.—*Phaostron Co., 151 Pasadena Ave., South Pasadena, Calif.*

For more information circle **308** on inquiry card.

Voltmeter Kit



New "Model FV-1" vacuum-tube voltmeter kit is said to utilize best components on market. 4½-in. indicator, tubes, assembly material, test leads and detailed assembly manual. Ranges to 1500 v.dc. and to 1000 v.ac.; 0.1 ohm to 1000 megohms.—*Franklin Electronics, King St., Franklin Park, Illinois.*

For more information circle **309** on inquiry card.

A-c. Electronic Voltmeter

New "Model E-33" indicates alternating voltages from 500 uv. to 500 v.; frequency range 10 cps.-1Mc.; operated from 105-130 v.ac.; power consumption 15 watts. Scale is logarithmic over one cycle (10 to 1), voltage

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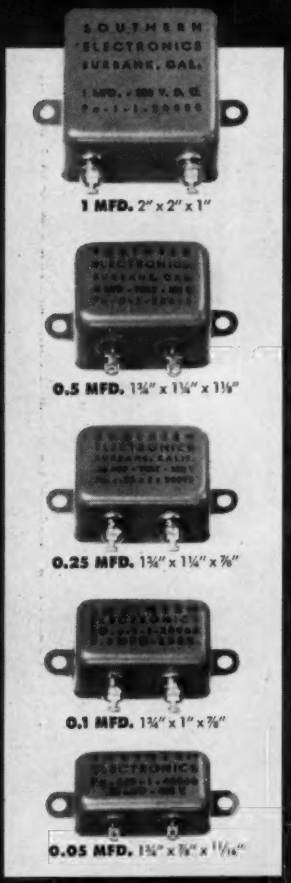

as low as 0.1% tolerance in most values!

Check these outstanding features:

- Capacitance Available - 0.05 to 10.0 MFD
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For more information circle **81** on inquiry card.

MINNEAPOLIS
Honeywell
Heiland OSCILLOGRAPH

The new Heiland Series 700C Recording Oscillograph will give consistent, unfailing service, provide a broad range of galvanometer frequencies and sensitivities, a wide selection of record speeds, and as many channels as you need.

For example, the Model 712-C features a 12-inch record width, with up to 60 channels.

If that's more than you need, the 708-C carries an 8-inch record with up to 36 channels.

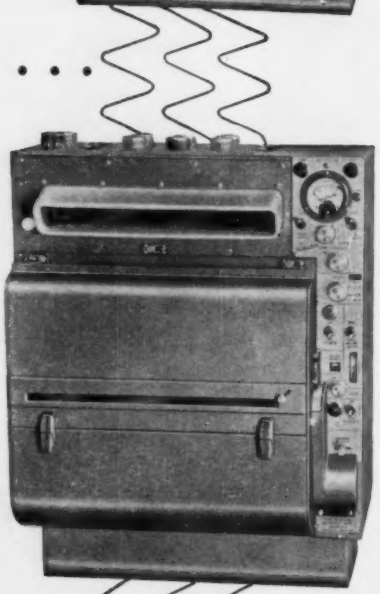
Easy access to galvanometer and damping resistor network is provided from the front by means of a hinged cover door.

ACCESSIBLE
easy to operate . . . . . .

Both models feature record speeds from .03"/sec. through 144"/second. Galvanometers with unequalled sensitivity ratings are available in frequencies up to 5000 cps. Either model may be relay-rack mounted if desired.

Heiland Series 700C Recording Oscillographs will simplify and expand the scope of your dynamic testing.

VISIT THE HONEYWELL BOOTH—#356-366 IRE SHOW, NEW YORK, MARCH 21-24.



Separate light-tight record drums permit easy daylight loading; access to drive gears permits instant selection of record speed ranges.

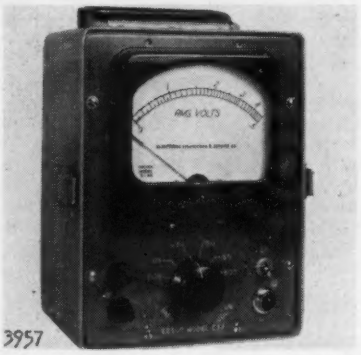
Write for Bulletin 700C-A for complete details.

Heiland®

A DIVISION OF MINNEAPOLIS-HONEYWELL
130 E. 5th Ave., Denver 3, Colo.

For more information circle **82** on inquiry card.

NEW INSTRUMENTS



range covered by six decades: 0.005, 0.05, 0.5, 5, 50 and 500. Input impedance 10 megohms, shunted by 17 uuf.—*Electronic Engineering & Service Co., Inc., 104 West Jefferson St., Falls Church, Va.*

For more information circle **310** on inquiry card.

Frequency Meter

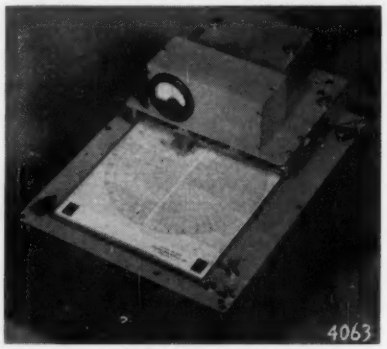
New "Model 360" uses tuned reeds with calibrated inertial properties,

lengths all equal. Reeds are gold-plated to prevent corrosion and maintain frequency. Range 380-420 cps.; frequency increments 5 cps.; energizing input less than 1.5 watt.—*The Winslow Company, Inc., 9 Liberty St., Newark, N. J.*

For more information circle **311** on inquiry card.

Polar Recorder

New "Model SPR," for recording antenna patterns and patterns of other directional devices, has self-con-

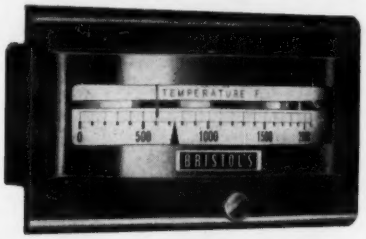


tained servo system with amplifier, powerpack, etc.; can also be furnished with a Selsyn motor alone (as "Model PR") having standard (36:1) or other (customer's spec.) gear reduction.—*Sound Apparatus Co., Stirling, N. J.*

For more information circle **312** on inquiry card.

Millivoltmeter

New "Model 580" features newly-developed high-torque jeweled mechanism with Alnico V magnet and self-



supporting coil; ambient temperature compensator; accuracy 1 percent of full-scale; less than 6 sec. for 99 percent response.—*The Bristol Co., Waterbury 20, Conn.*

For more information circle **313** on inquiry card.

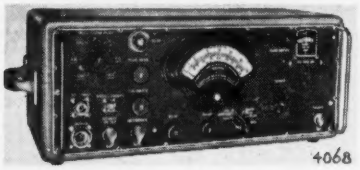
Low-resistance Bridge

New "Model 604," suited to lab as well as production line, rapidly checks low resistances (10 to 10,000 ohms) to accuracy of 0.25 percent. Front panel switch selects three full-scale ranges. Dial-lock on "Helipot" resistor enables pre-selecting a resistance value for rapid comparisons.—*Shasta Div., Beckman Instruments, Inc.*, 1432 *Nevlin Ave., Richmond, Calif.*

For more information circle **314** on inquiry card.

Radio Interference and Field Intensity Meter

New "NM-30A" is for accurate measurement of field intensities of signals and *RF* disturbances within



frequency range of 20 to 400 Mc.; may also be used as a two-terminal frequency-selective voltmeter; operates from either 105/125 or 210/250 v.ac. at any frequency between 50 and 1000 cps.—*Stoddart Aircraft Radio Co., Inc.*, 6644 *Santa Monica Blvd., Hollywood* 38, *Calif.*

For more information circle **315** on inquiry card.

Oscillograph

New "150 Series" single-channel oscillographic recording system utilizes plug-in preamplifiers, permitting simple changeover from one type of recording to another. Anv of seven available "150" preamplifiers (ac-dc, carrier, servo monitor, dc. coupling, log-audio, low level, and input coupling) can plug into a driver amplifier-power supply unit (Model 150-

For more information circle **83** ⟶

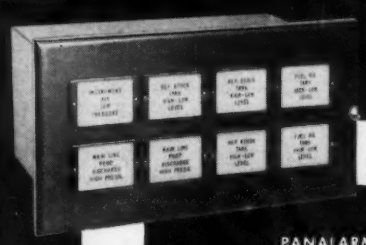
PANALARM "50" ANNUNCIATOR SYSTEMS

PANALARM "50" PLUG-IN UNIT . . . hermetically sealed and most versatile ever developed . . . simply plugs into chassis to expand system . . . no wiring . . . no other connections. Corrosion-proof and suitable for Class I, Div. 2 locations.

NEW functional flexibility with NEW "instrument-type" construction

Built-in flexibility of PANALARM "50" allows simple change-over to any operating sequence as required by present or future conditions. And, at the same time PANALARM "50" introduces a new instrument-type annunciator construction . . . adding to the long-term dependability of the entire system.

CABINET is substantial gauge steel with sturdy chassis and sub-door arrangement. It is pre-wired ready for installation, yet completely flexible without re-wiring.



PANALARM ANNUNCIATOR SYSTEMS are self-contained with either illuminated name-plates or bullseye visual signals. Both the audible signal and acknowledgment button are common to the entire system.

SEND FOR COMPLETE 40-PAGE MANUAL

Ask for Catalog 100-1

PANALARM

PANALARM PRODUCTS, INC.
7405 N. Hamlin Ave., Skokie, Illinois

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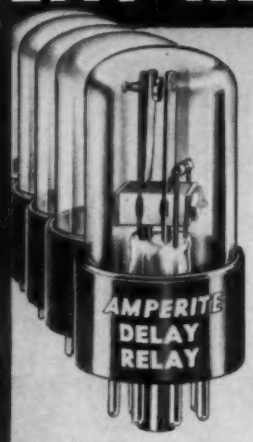
THERMOSTATIC

DELAY RELAYS

Provide delays ranging from 2 to 150 SECONDS



STANDARD

MOST COMPACT
MOST ECONOMICAL
HERMETICALLY SEALED

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- Circuits: *SPST only*—normally open or normally closed.

Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from —55° to + 70°C. Heaters consume approximately 2 W. and may be operated continuously.

The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive! TYPES:* Standard Radio Octal, and 9-Pin Miniature.

MINIATURE

PROBLEM? Send for Bulletin No. TR-81

Also—a new line of **Amperite Differential Relays** — may be used for *automatic overload, over-voltage, under-voltage or under-current protection.*

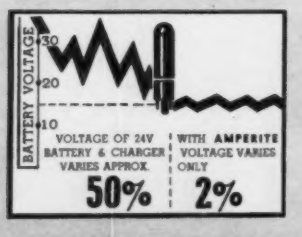
AMPERITE

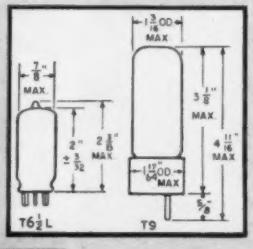
BALLAST REGULATORS

T9 BULB

- Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp).
- For currents of 60 ma. to 5 amps. *Operates on A.C., D.C., or Pulsating Current.*
- Hermetically sealed, light, compact, and most inexpensive.

Amperite Regulators are the simplest, most effective method for obtaining ***automatic regulation*** of current or voltage. ***Hermetically sealed,*** they are not affected by changes in altitude, ambient temperature (—55° to +90°C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.





AMPERITE CO., Inc.

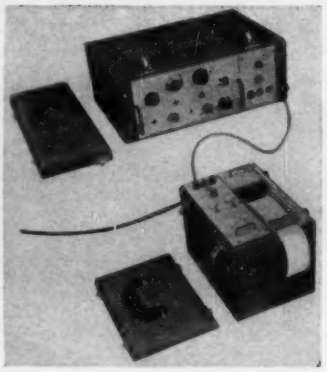
561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp., Ltd., 560 King St., W., Toronto 2B

Write for 4-page Technical Bulletin No. AB-51

For more information circle **84** on inquiry card.

NEW INSTRUMENTS



200/400), housed in a carrying case. Simple patch cord connection couples amplifier to separately-housed recorder (Model 151-100A). Among features: inkless recording in true rectangular coordinates, paper speeds of 5, 10, 25, 50 and 100 mm/sec.; extra stylus for time marking or coding (manual or remote) along chart edge.—*Sanborn Co., Industrial Div., Cambridge* 39, *Mass.*

For more information circle **316** on inquiry card.

Watthour Meter

New "I-55" extended-range watthour meter features a capacity of 100

amps., can handle loads up to 667 percent of nameplate rating.—*Meter Dep't, General Electric Co., West Lynn* 3, *Mass.*

For more information circle **317** on inquiry card.

Watthour Meters

New models of maker's watthour meters feature improvements in both types—detachable mounting ("DS") and bottom connection ("DA"). Overload capacity has been increased: for 15-amp. rating it is 100 amps. instead of 60; for 30-amp. rating, 200 amps. Insulation has been improved and made more stable thermally. Both potential and series coils withstand 15,000-v. impulses. Socket-type meter has a "De-ion" arrester. Both full- and light-load adjustments can be made from front, with fingers or screwdriver. Register can be removed without meter losing its serial-number identity. A disc guard makes it possible to lay meter, cover removed, on its face without damage to disc.—*Westinghouse Electric Corp., Box* 2278, *Pittsburgh* 30, *Penna.*

For more information circle **318** on inquiry card.

Signal Generator

New "Model E-300 Sine-Square Wave Signal Generator" is a new basic test instrument covering audio-

video range; was especially developed for electronic amplifier testing.—*Precision Apparatus Co., Inc.*, 92-97 *Horace Harding Blvd., Elmhurst, L. I., N. Y.*

For more information circle **319** on inquiry card.

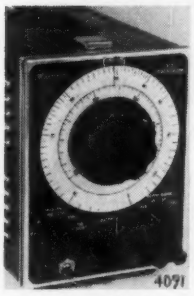
ELECTRICAL INSTRUMENT ACCESSORIES

Frequency Standard

New transistor-operated frequency standard for airborne, mobile and portable applications is housed in an octal-based 1½-in. diam. by 4½-in. case, hermetically sealed, shock mounted and magnetically shielded; weighs 7 oz. At present, units are available in 400 and 500 cps. Output is a sine wave of 5 to 7 volts into 100,000 ohms or more.—*American Time Products, Inc.*, 580 *Fifth Ave., New York 36, N. Y.*

For more information circle **320** on inquiry card.

Oscillator

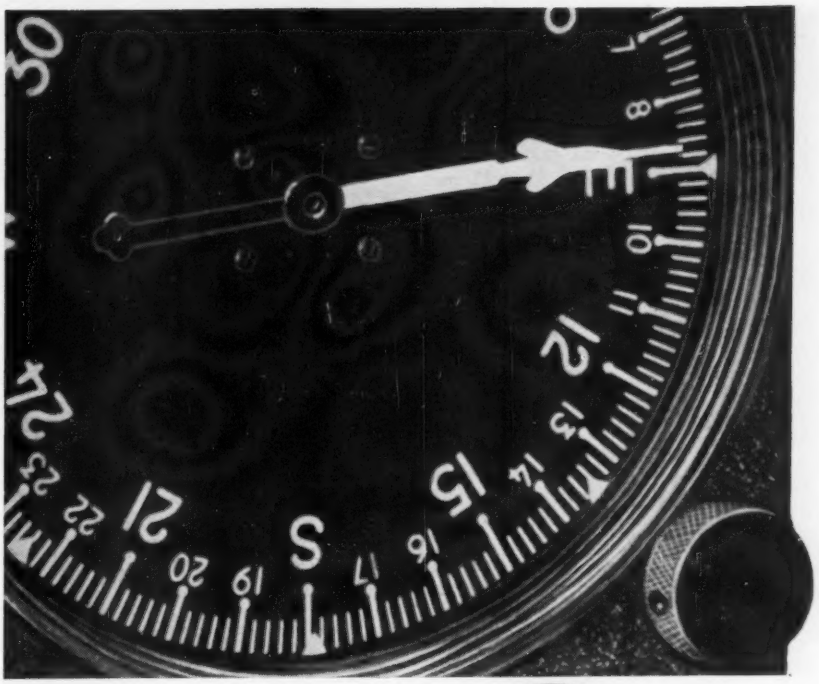


New "Model 512 Extended-range Oscillator" features 0.1 percent distortion, 2-watt output, and frequency range from 500 kc. to less than 1 cps. A four-step attenuator provides calibrated output from 50 v. to 5 mv. Vernier drive provides 14 in. of scale length for each of five decade ranges: total scale length 6 ft. Output remains constant within ½ db throughout tuning range. Instrument operates from 50- to 400-cps. lines.—*Waveforms, Inc.*, 333 *Sixth Ave., New York 14, N. Y.*

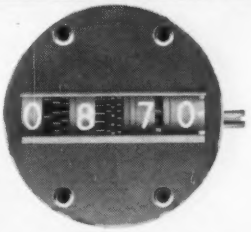
For more information circle **321** on inquiry card.

Balanced Mixer

New balanced magic tee mixer in 1 x ½ in. OD waveguide size, suitable for use in lab or radar, has low noise figure over its entire 12 percent bandwidth. Through use of both direct and reversed crystal mounts, two in-phase intermediate frequency signals are produced in mixer from received sig-



Both the Counter and the Dial Indicator are shown full size.



WHICH IS READ WITH GREATER ACCURACY?

The Kearfott Counter shown can be read with the same ease and accuracy as a dial indicator 143 inches in diameter.

Ball Bearings and precision hardened steel parts used in Kearfott Counters permit their high speed rotation for long periods of time. Kearfott Counters are capable of being driven at 1800 RPM. Precision parts also contribute to precise positioning and precise reading.

STANDARD KEARFOTT TYPES

ANGLE COUNTERS: Odometer indication of shaft position, fully reversible operation returning to 0° at end of count. Either 0°-359.9° in 1/10 or 0°-359° in ½° increments as desired. Maximum speed 1800 RPM.

DECIMAL COUNTERS: High speed decimal count from 0-9999 and return to 0 in ½ increments. Maximum speed 1800 RPM. One revolution of shaft equals 10 units.

LONGITUDE COUNTERS: For east-west longitude indication in degrees and minutes in ½ minute increments. Mask transfers hemispheric indication at 0° and 179°59'. Maximum speed 1800 RPM.

LATITUDE COUNTERS: Indicates N 89°59' to S 89°59'. For same direction of input the mask transfers hemispheric indication and reverses reading at 00 degrees 00 minutes. Maximum speed 1800 RPM.

Variations of these Standard Types are available for special purposes.

KEARFOTT DISPLAY AT THE NATIONAL I.R.E. SHOW, KINGSBRIDGE ARMORY, NEW YORK, BOOTH 152.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Send for bulletin giving data of Counters and other components of interest to you.

Kearfott

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KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

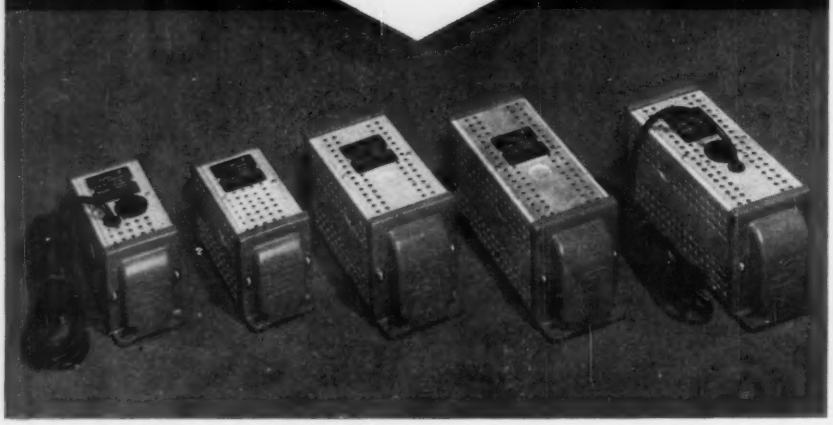
For more information circle **85** on inquiry card.

NEW! NEW! NEW!

MAGNETIC VOLTAGE REGULATORS

These Magnetic Voltage Regulators, or Regulating Transformers, are the first units in a comprehensive line of equipment of this type being developed by Sorensen. They are primarily intended for incorporation into other equipment, where performance becomes more effective when the incoming line voltage is stabilized. However, they can be used as auxiliary line stabilizers.

The units now available have capacities of 15, 30, 60, and 120 VA. Soon to be added will be units of 250, 500, and 1000 VA capacities.



ELECTRICAL SPECIFICATIONS

Input voltage range	95-130 VAC, 1ϕ, 60 cycles.
Output range	115 VAC, RMS, 1ϕ.
Regulation accuracy	±0.5% against line changes.
Load conditions	±0.5% against line at any given load from 0 to full load.
Time constant	From 2 to 6 cycles for line changes.

MECHANICAL SPECIFICATIONS

Model MVR15	Length 6½", Width 2⅞", Height 3½"
Model MVR30	Length 6½", Width 2⅞", Height 3½"
Model MVR60	Length 8⅝", Width 3½", Height 4¼"
Model MVR120	Length 9⅝", Width 3½", Height 4¼"

Send for Catalog MVR1, which gives full information on the magnetic voltage regulator line.

Since Sorensen is now offering a new type of line voltage regulator, your inquiries regarding special requirements in magnetic voltage regulators will be welcomed. Write to the Sales Engineering Department, Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford. Conn.

SORENSEN

SORENSEN & CO., INC., 375 FAIRFIELD AVENUE, STAMFORD, CONN.

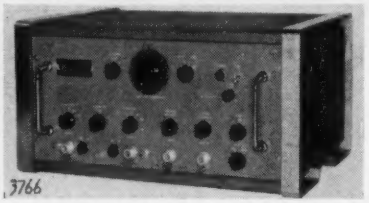
For more information circle **86** on inquiry card.

nal and local oscillator signal with resultant cancellation of local oscillator noise. Isolation between local oscillator and signal input arms is greater than 30 db. VSWR of each signal input is less than 1.25 over mixer's operating frequency range of 8500 to 9600 Mc. Added feature of new balanced mixer is that it comprises several pieces of useful test equipment.—*Airtron, Inc., Linden, N. J.*

For more information circle **322** on inquiry card.

Electronic Switch

New "Model ES-180 Wide Band Electronic Switch" provides d.c. to 15-Mc. dual-trace oscilloscope presen-

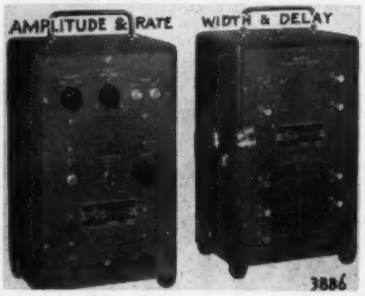


tation. Because of stability of both amplifier channels and their practically identical characteristics, it is possible to compare two signals in time with accuracy of one millimicrosecond.—*Teletronics Lab., Inc., Westbury, N. Y.*

For more information circle **323** on inquiry card.

Pulse Generator

New "Model PG-215 Milli-Microsecond Pulse Generator" produces rectangular waveforms having rise, duration and decay times in millimicrosecond range; also furnishes



an isolated trigger signal, advanced in time with respect to main pulse, for synchronizing associated equipment.★ "Model PGA-220 Width and Delay Unit" provides 25 different sets of values of rise and decay time.—*Teletronics Lab., Inc., Westbury, N. Y.*

For more information circle **324** on inquiry card.

Fixed-frequency Oscillators

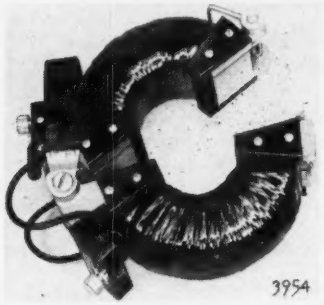
New "Model DK-1" low-distortion fixed-frequency power oscillators feature essentially pure highly stabilized sine-wave power at 10-volt 2-watt 0.03-

ohm impedance, for general laboratory and production testing. Frequency is factory fixed to customer's order 300 to 10,000 cps; a trimmer provides fine adjustment. Circuit is *L-C* bridge type, incorporating a high-*Q* toroid, combined with a self-balancing feedback amplifier.—*Neucor, Inc., 45 West Union St., Pasadena 1, Calif.*

For more information circle **325** on inquiry card.

Current Transformer

New "Type W-400 Knopp Split-Core Transformer" is for use with a rotating standard, also with indicating ammeters and wattmeters. Primary ranges 200 and 400 amps., also 100, 50, 40, 20 and 10 with an ac-



cessory 40-turn primary coil; 1- or 5-amp. secondary; voltages, 600 or 2500. Ratio at full-load is within 0.15 percent and phase-angle within three minutes leading. Between 20 and 100 percent of full-load current, ratio slope does not exceed 0.05 percent and phase-angle slope does not exceed three minutes.—*Electrical Facilities Inc., 4250 Holden St., Oakland 8, Calif.*

For more information circle **326** on inquiry card.

POWER SUPPLIES

D-c. Supply

New "Model UHR-245" furnishes continuously-variable voltage from 150 to 500 v.dc. up to 500 ma. with 0.002 percent load regulation and less than 100 uv. ripple. Among features: drift-cancelling differential amplifiers; new high-stability reference tube; two independent 6.3-v.ac. 10-amp. outputs.—*Krohn-Hite Instrument Co., 580 Mass. Ave., Cambridge 39, Mass.*

For more information circle **327** on inquiry card.

Pocket-size Supply

New "Model 301 Multivolter Power Supply," fitting in pocket, tool box, etc., provides variable dc. voltage from minus 135 to plus 135; 0 to 135 v.ac.; one amp. of 6.3 filament voltage; neon indicator extinguishing when 20 ma. is drawn.—*Authorized Mfg. Co., 919 Wyckoff Ave., Brooklyn 27, N. Y.*

For more information circle **328** on inquiry card.

Regulated D-c. Supplies

New d-c. power supplies comprise (1) "High Ambient Selenium Rectifiers" which convert a-c. to d-c. power; (2) fast-response magnetic amplifiers which regulate direct voltage within 1 percent of selected value; (3) auxiliaries including protective equipment, indicating instruments, cooling fans, etc. No moving parts or electron tubes in conversion-regulation components. Standard models 5, 7.5, 10,

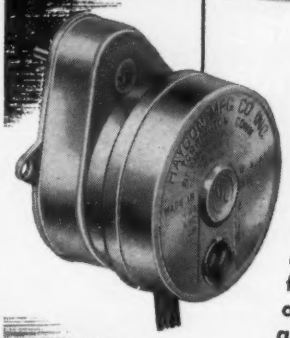
NEW CONCEPTS

NEW POTENTIALS

HAYDON*

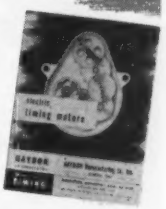
Because manufacturers must have better products, they rely on **you** *— the designers and engineers who have the ability to apply skill and experience with* **IMAGINATION** *— to develop new and better products and methods! Ready to work with you are industrials with the same vision and creative talents. In the field of timing motors, HAYDON is such a company.*

because new IDEAS take TIME and TIMING!



4400 Series Timing Motor

If 60 cycle, 400 cycle, or d-c timing motors are to be used in your product or process, call in the nearby factory-trained HAYDON Field Engineer. He can help you find the right motors for precisely, dependably using time . . . controlling time . . . metering time — ***for bettering performance and opening new horizons to product and process use.*** *Clip and mail the coupon for his name . . . and for an informative catalog —* **today!**



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CITY _____ ZONE ____ STATE _____

For more information circle **87** on inquiry card.

SIE

MODEL D-1

DIRECT-COUPLED AMPLIFIER

for reliable amplification of low-level signals in:

COMPUTER DESIGN • CHEMICAL, BIOLOGICAL AND MEDICAL INVESTIGATIONS • VOLTAGE MEASUREMENT • VIBRATION ANALYSIS

The SIE Model D-1 Direct-Coupled Amplifier offers high gain, wide dynamic range, and extremely low distortion in a design which favors a wide range of laboratory investigations. Unique input "zeroing" circuit allows small voltages to be read "full-scale." Meter on front panel provides direct reading information.

- Single-ended or Differential Input
- Self-contained Power Supply (No batteries required)
- Wide frequency range
- Relay rack or bench mounting

Specifications:

GAIN: 80,000 at 50 kc. (1,000 at 120 kc.)
INPUT IMPEDANCE: 10 Megohms or open grid
INPUT NOISE: Less than 10 microvolts
MAXIMUM INPUT SIGNAL: 18 volts rms.
MAXIMUM OUTPUT SIGNAL: 80 volts (Distortion less than 1%)
DRIFT: Less than three millivolts per hour
IN-PHASE REJECTION RATIO (Differential input): More than 1500 to 1 at gain of 1000.

SIE

Price: $515

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.
INDUSTRIAL INSTRUMENT DIVISION
P. O. Box 13058 2831 Post Oak Road Houston, Texas

204 55 REPRESENTATIVES THROUGHOUT THE WORLD

For more information circle **88** on inquiry card.

NEW INSTRUMENTS

15, 25, 37.5 and 50 kw. D-c. output 125- or 250-v., either voltage obtainable by a simple internal reconnection.—*Vickers Electric Division, Vickers, Inc., 1815 Locust St., St. Louis 3, Mo.*

For more information circle **329** on inquiry card.

Low-voltage Supplies

New "Models CV5, 10, 15, 20, 25, and 30 Transpacs" can be wired into circuits like other components; provide direct voltage reference or d-c. power for magnetic amplifiers, transistor equipment, vacuum-tube biasing and other contact-voltage applications. Output voltages 5, 10, 15, 20, 25, and 30; max. current 15 ma.—*Electronic Research Associates, Inc., 715 Main St., North Caldwell, N. J.*

For more information circle **330** on inquiry card.

Variable-frequency Supply

New "Model 1420-B Generator," for use in development or production testing, provides 50-6000-cps. frequency range with internal oscillator and 25-20 kc. with external oscillator; power output 300 va.; regulation less than 2 percent no-load to full-load. Nominal output voltages 80, 120, 135, 215, 255 and 270.—*Communication Measurements Lab., 350 Leland Ave., Plainfield, N. J.*

For more information circle **331** on inquiry card.

AMPLIFIERS

Wide-band Preamplifier

New "Type 53G Differential Wide-Band Plug-In Preamplifier," for use with 'scopes, features dc. to 10 Mc. frequency response; 0.035 usec. rise-time; sensitivity continuously variable from 0.05 to 50 v./cm. Common-mode rejection is better than 100 to 1 for entire passband at full gain; better than 300 to 1 at 60 cycles. Weight 4½ lbs.—*Tektronix, Inc., P. O. Box 831, Portland 7, Oregon.*

For more information circle **332** on inquiry card.

D-c. Amplifier

New "Model 62A Stabilized DC Amplifier" contains its own complete power supply; has a pass band from 0 to 25 kc.; zero drift restricted to 20 microvolts equivalent input over any period of operating time; gain of 1000; linearity to 0.25 percent. Six amplifiers are mounted in an 8¼-in. panel space of a standard 19-in. relay rack. Accessory equipment includes strain gage bridge balance and supply,

and an output amplifier for driving pen motor recorders and high-frequency string galvanometers.—*Electro-Mechanical Research, Inc., Ridgefield, Conn.*

For more information circle **333** on inquiry card.

Calibrated Amplifier

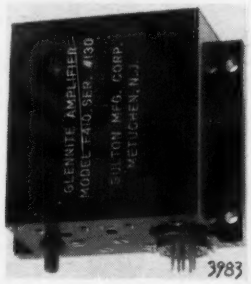
New "Model M-185" has a stabilized fixed gain of 60 db; high-precision attenuator has six 10-db steps and one continuous 0-10-db step; input noise

level less than 10 uv. for entire 10-cps.-400-kc. range; 2-megohm impedance input terminals are provided and low-impedance output terminals are available.—*Massa Laboratories, Inc., Hingham, Mass.*

For more information circle **334** on inquiry card.

Subminiature Preamplifier

New "Glennite Model F 410" for use with missiles, etc., weighs 6 oz.; is a four-tube unit incorporating a



cathode follower input to give an input impedance of 100 megohms. Selective gains 10, 30, and 100; frequency response 5 to 20,000 cps.—*Gulton Mfg. Corp., Metuchen, N. J.*

For more information circle **335** on inquiry card.

ELECTRICAL & ELECTRONIC COMPONENTS

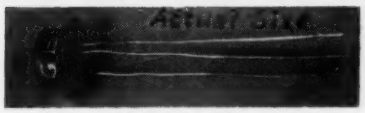
Resolvers

New high and low impedance "Size 11 Resolvers" for data reduction systems, industrial process control, radar etc., feature reliable operation at temperature of –55 C. to 85 C.; weigh 4.7 oz., have 1.065 in. O.D. by 1.85 in. BuOrd type case.—*American Electronic Mfg., Inc. 9503 West Jefferson Blvd., Culver City, Calif.*

For more information circle **336** on inquiry card.

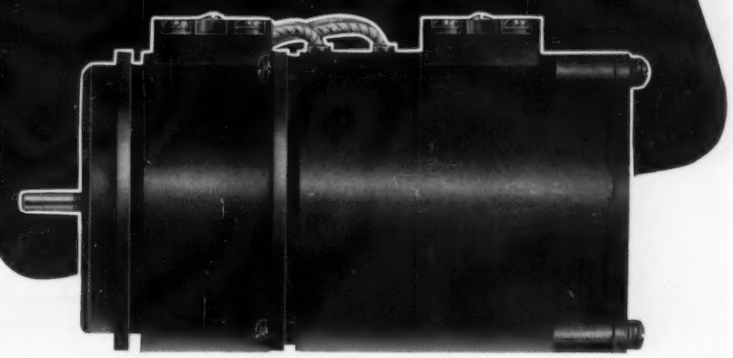
P-N-P Transistor

New "2N76" low-cost fused-junction transistor is for designers and hobbyists. Shelf life and exposure to full

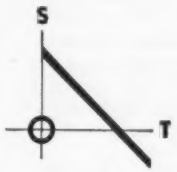


Tachometer Feedback

with Instrument Servo Motors



and now, a DIEHL Instrument Servo Motor and Integrally-Mounted Alternating Current Tachometer-Generator assures stability in a Servo loop. Designed for simple and easy mounting and can readily be adjusted after installation so that the in-phase residual voltage is essentially zero. A high impedance control-phase winding is available for plate to plate operation. 57½/57½ volt control-phase windings can be provided for magnetic amplifier applications. Diehl Motor-Tachometer combinations are obtainable with Gear Reducers in 5 different ratios. Attractively priced for commercial applications.



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1, 5 and 10 watts output	Input (volts)	115
GEAR REDUCTION RATIOS	Frequency (cycles)	60
191.1 to 1 76.6 to 1 32.4 to 1 13.8 to 1 5.8 to 1	Output (volts per 1000 RPM)	5.5
	Linearity	1%

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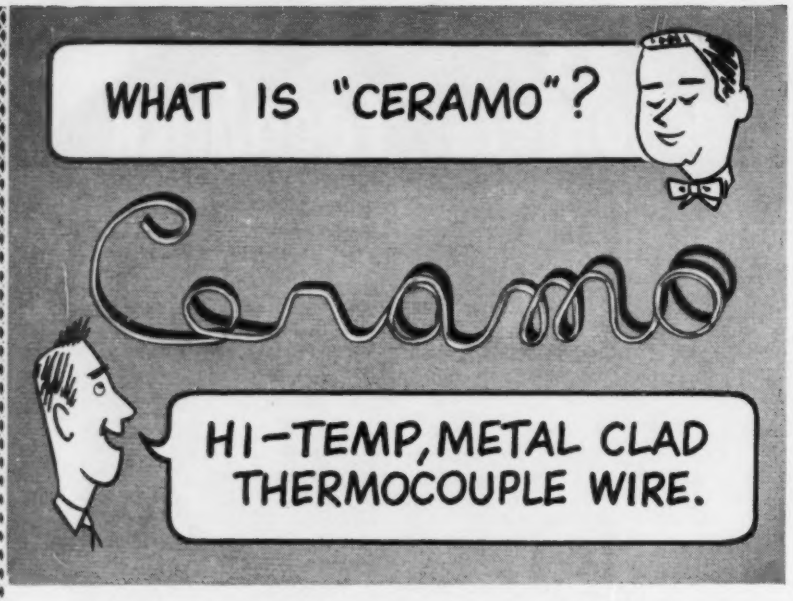
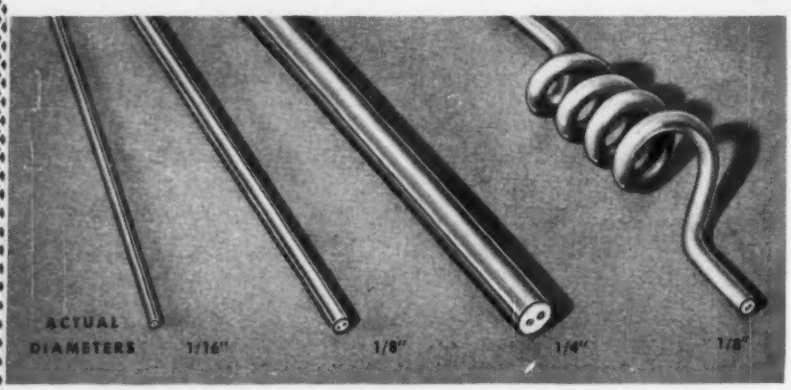
For more information circle **89** on inquiry card.



T-E's "Ceramo" wire consists of thermocouple material conductors, surrounded by magnesium-oxide insulation, with seamless metal tubing overall.

Thermocouples or extensions made of "Ceramo" wires will fit into openings that are too small for most ordinary thermocouples or extensions. Furthermore, they can be formed easily to any configuration without short-circuiting—in fact, "Ceramo" can be bent on a radius as small as its own diameter. The durability of the outer metal tube makes conduits unnecessary. Not even a hammer blow will injure it; in fact, it will withstand pressures up to 40,000 psi. These metallic clad wires have excellent resistance to high temperature, moisture, chemicals, petroleum products, atomic radiation or abrasion.

"Ceramo" thermocouple wires are made in Iron-Constantan, Chromel-Alumel, Copper-Constantan, Chromel-Constantan, and Platinum-Rhodium Platinum. Wires are sheathed with seamless tubing of stainless steels, Inconel, aluminum, or copper. Made with 30, 22 and 16 gage conductor material; overall diameters of 1/16", 1/8", and 1/4" respectively; lengths up to 30 ft.



"Ceramo" thermocouple extension wires are made in Iron-Constantan, Chromel-Alumel, or Copper-Constantan with copper-nickel alloy, plain or galvanized cold drawn steel sheath overall. Made with 20 and 16 gage conductor material; overall diameters of 1/8" and 1/4" respectively; lengths up to 2000 ft., depending on the type of metal tubing and outside diameter. "Ceramo" is made also in single conductors or multiconductor cables.

Interested? Write for bulletin 31-300-F.

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For more information circle **90** on inquiry card.

rated temperature will not change its characteristics. It has a maximum frequency cutoff at 2.5 Mc.; design center at 1.0 Mc. Alpha design center 0.95; maximum collector voltage –20; maximum junction temperature 60 C.—*Germanium Products, General Electric Co., Syracuse, N. Y.*

For more information circle **337** on inquiry card.

Voltage Regulators

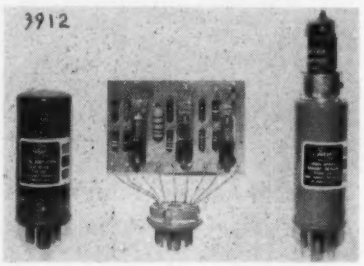
New line of magnetic voltage regulators (regulating transformers) comprises units with capacities of 15 to 120 va. primarily intended for incor-

poration into other equipment but usable as auxiliary line stabilizers. Regulation accuracy 0.5 percent against line changes; load conditions 0.5 percent against line at any given load from 0 to full.—*Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn.*

For more information circle **338** on inquiry card.

Packaged Circuits

New "Pakaps" packaged circuits, etched on impregnated Teflon, are offered in three series having applica-

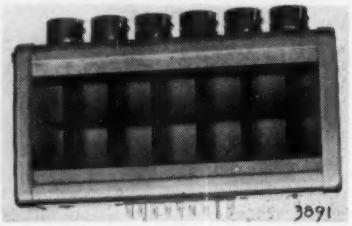


tion in (1) computer and airborne instrumentation, (2) laboratory equipment and (3) hi-fi. No potting material is used and units are repairable. —*Audio Products Corp., 2265 Westwood Blvd., Los Angeles 64, Calif.*

For more information circle **339** on inquiry card.

Plug-in Units

New plug-in mounting packages permit single or multi-tube units to be easily assembled in new "Lip-Loc" cases with "Snap-Open" side panels, locks, choice of plugs and finishes. New



internal modular structures can be furnished in forms of deck turrets, wall turrets or tinker-turrets with "clip-in Zip" terminals.—*Vector Electronic Co., 3352 San Fernando Rd., Los Angeles 65, Calif.*

For more information circle **340** on inquiry card.

Bobbin Cores

New "Performance-Guaranteed Bobbin Cores," especially suitable for use as memory cells for electronic

computers, are wound on small ceramic bobbins with ultra-thin magnetic tapes; are offered in a complete line.—*Magnetics, Inc., Butler, Penna.*

For more information circle **341** on inquiry card.

Pulse Transformers

New "Type GEM" pulse transformers for printed circuitry are available in pulse widths from 0.05 to 2 usec.; two or three windings; operating temperature range –70 C. to 135 C.; surpass MIL-T-27 (grade 1, class A) test specs.—*Gudeman Co. of California, Inc., 9200 Exposition Blvd., Los Angeles 34, Calif.*

For more information circle **342** on inquiry card.

Twin-T Networks

New plug-in units of "Types 501 and 502" (22 models each) twin-T networks are *RC* null circuits: wire-wound resistors and silvered mica or polystyrene capacitors.—*White Instrument Labs, 203 Riverside Drive, Austin 4, Texas.*

For more information circle **343** on card.

Pulse Transformers

New epoxy-resin-impregnated molded 7-pin plug-in miniature pulse transformers surpass MIL-T-27, grade 1, class A. Pulse width range 0.25 to

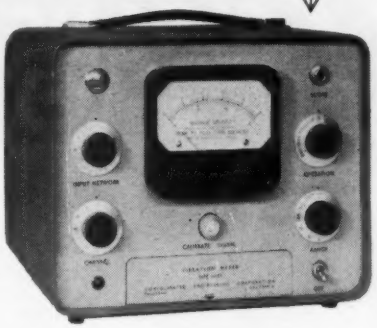
25 usec. Weight range is from 10 to 15 grams. Operating temperature range –70 C. to 135 C. Hi-pot test 2000 v.rms.—*The Gudeman Co. of California, Inc., 9200 Exposition Blvd., Los Angeles 34, Calif.*

For more information circle **344** on inquiry card.

Ladder Network

New "Series LA-920" unbalanced ladder network allows continuous variation of attenuation; is recommended for use where sound levels must be changed smoothly without any transient disturbances, or where levels

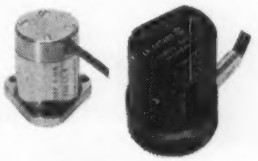
in one vibration meter...

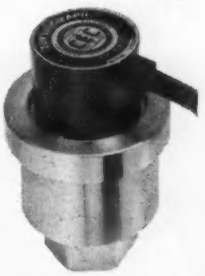


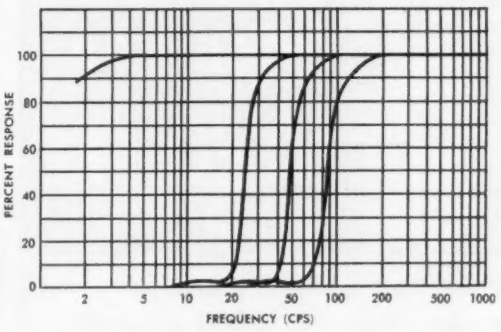
...laboratory accuracy ...factory ruggedness

Use it for the most critical laboratory work ... then take it out on the production line for turbo-prop or jet-engine check-out. CEC's Type 1-117 does both, with a combination of accuracy and ruggedness not found in any other meter. It is particularly suitable for aircraft power plant vibration measurements ... can be used anywhere, even by inexperienced personnel. Coupled with any CEC precision vibration pickup, the 1-117's outstanding flexibility makes it the ideal *general-purpose* system for measurement or monitoring.

Pickups are available for either linear or torsional vibration measurements.







Plug-in filters permit optional cutoff of low-frequency vibrations at 30, 70 or 110 cps. ... give you *four meters in one.* Send for Bulletin CEC 1538A-X1.

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For more information circle **93** on inquiry card.

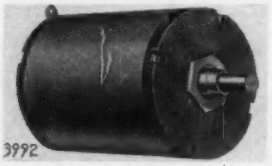
NEW INSTRUMENTS

must be set closer than in step type units. Rotational life over 1,000,000 cycles. In addition to catalog types, special designs to meet customer specs. —*The Daven Co.*, 191 *Central Ave., Newark* 4, *N. J.*

For more information circle **345** on inquiry card.

Variable Delay Lines

New "Helidel" units are of continuously-variable distributed-constant electromagnetic type; delay adjustable in increments of 0.00002 usec.; rise-



time 0.0175 usec. maximum; 20 Mc. band-width; negligible overshoot or phase-distortion. Two standard models: 10-turn unit with total delay of 0.2 usec. and 15-turn 0.3 usec.—*Helipot Corp.*, 916 *Meridian Ave., South Pasadena, Calif.*

For more information circle **346** on inquiry card.

Pyrex-glass Capacitors

New glass-case capacitors will use tempered Pyrex brand glass as tubing case, with greater resistance to thermal shock and higher voltage breakdown resistance.—*Condenser Products Co., Div. New Haven Clock and Watch Co., New Haven, Conn.*

For more information circle **347** on inquiry card.

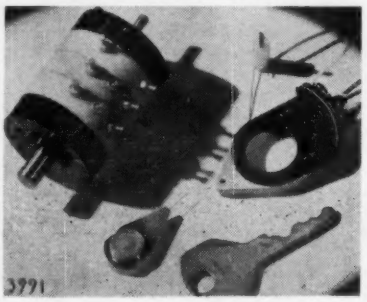
Air Capacitors

Two new smaller models of concentric high ratio air capacitors feature convenient ranges of capacitance; high Q; voltage breakdown over 750 v.dc. and a high degree of stability. "Type 1800" has a minimum of 0.4 mmf. and a maximum of 12 mmf.; "Type 1900" 0.6 and 30 mmf. Mechanically: miniature size and rugged construction; improved stop and double spring fingers assure stability and eliminate backlash; materials are silver-plated brass and Pyrex glass; contact surfaces of rotor are rhodium-plated. Units also available with Invar construction.—*Johanson Mfg. Corp., Boonton, N. J.*

For more information circle **348** on inquiry card.

Precision VDRs

New precision voltage-dividing resistor components for aircraft and instrument systems are available with resistance wire 0.4 mil and up, with adjustable terminals and taps. Ganged



units are adjustable for both total length and electrical centers.—*Helco Products Corp.*, 2041 *Colorado Ave., Santa Monica, Calif.*

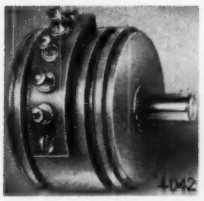
For more information circle **349** on inquiry card.

Liquid-dielectric-type Voltage Divider

New "Type PD-2 Dielectric Potentiometer" utilizes a completely new and unique principle whereby it is free of phase and frequency distortion over exceptionally wide range of 20 cps. to 10 Mc. Output voltage has identical waveform of input voltage, so that unit excels as a calibrated attenuator in wide-band systems. In effect, it is a 3-terminal network, whose effective *RC* shunt and series elements result from inherent resistivity and dielectric constant of a lossy liquid dielectric immersing terminal electrode structures. Output electrode can move with respect to input electrode. Since *R* and *C* components vary in exactly inverse manner with movement of output electrode, a precisely constant *RC* product is maintained in ratio arms. Principle permits wide design flexibility.—*Technology Instrument Corp., Acton, Mass.*

For more information circle **350** on inquiry card.

Wire-wound VDR



New miniature "Model 106" wire-wound voltage-dividing resistor combines small size (1-1/16 in.) light weight, wide choice of resistance values or functions and ganging features.—*George Rattray & Co., Inc.*, 116-08 *Myrtle Ave., Richmond Hill* 18, *N. Y.*

For more information circle **351** on inquiry card.

Encapsulator Resistors

Eight new "Type P" encapsulated resistors, self-supporting on #20 AWG wire axial leads, are especially valuable in compact assemblies where space and weight are limited. Mineral-filled epoxy resin coating provides maximum environmental protection (meeting salt-water immersion requirements of former JAN-R-93), permits rapid heat dissipation, and is light in weight.—*Shallcross Mfg. Co., Collingdale, Penna.*

For more information circle **352** on inquiry card.

Film-type Resistors

New "Series 850" hermetically-sealed metal film type resistor fills gap between precision wire-wound types and low-cost composition types. Innovation: pure noble-metal resistive element is deposited on INNER surface of a glass tube. Performance characteristics far exceed MIL-R-10509A. Now available in ½, 1 and 2 watt sizes, wide range of resistance values.—*The Daven Co.*, 191 *Central Ave., Newark, N. J.*

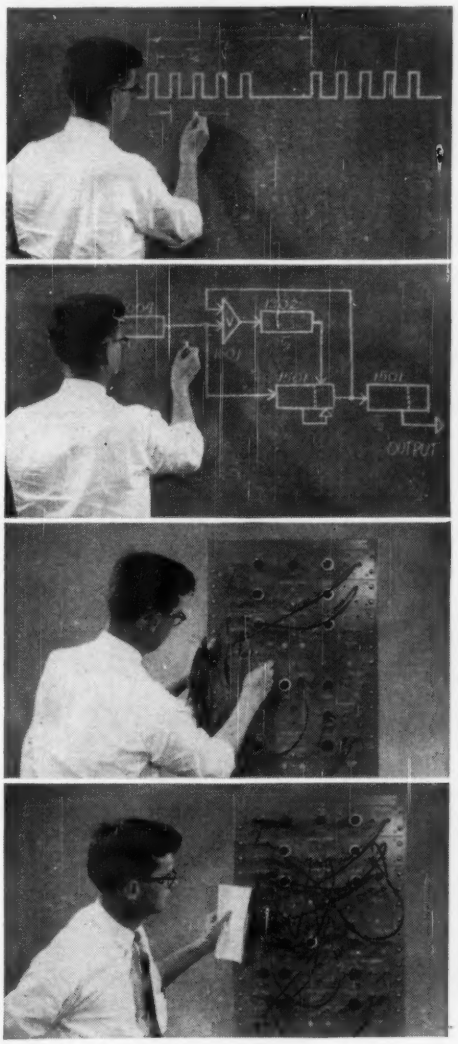
For more information circle **353** on inquiry card.

Power Resistors

New "Types R31, R32, R34, and R36 Castohm" cast ceramic power resistors are added to maker's line of

Engineer assembles pulse system in 30 minutes, using Burroughs "do-it-yourself" units

Standard, matched units, performing basic functions, connect together to form even the most complex pulse systems



1. START

Engineer studies time chart of the desired pulse sequence. This is the output he wants the pulse system to produce.

2. PLANNING THE SYSTEM

He determines which Burroughs units he needs and how they should be connected together. This can be done by means of a simplified block diagram. Time: 10 minutes.

3. ASSEMBLING THE UNITS

Using standard coaxial cables, he completes his pulse system by connecting the units together according to his block diagram. Time: 20 minutes.

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System now produces the exact pulse sequence desired. Engineer saves weeks of breadboard engineering, vital time, uncertainty, and considerable equipment cost. And his Burroughs "Unitized" pulse handling equipment can be used over and over again on different future projects.

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No matter how complex the pulse sequence you need, you can produce it quickly and at relatively low cost with Burroughs "Unitized" pulse handling equipment. If you prefer, send us a timing diagram of the pulse sequence required, and we'll advise you what Burroughs units you need and the cost. Immediate delivery from stock. Write Burroughs Corporation, Electronic Instruments Division, Dept. 5C, 1209 Vine St., Phila. 7, Pa.

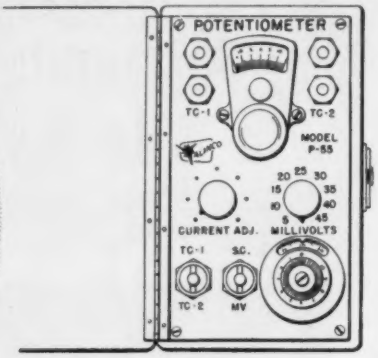
ELECTRONIC INSTRUMENTS DIVISION

Burroughs

FIRST IN PULSE HANDLING EQUIPMENT

For more information circle **94** on inquiry card.

A miniaturized POTENTIOMETER



The miniaturized Potentiometer, Model P-55, weighs only three and one half pounds, and measures just 4 1/8 x 4 1/2 x 7 1/2 inches, yet is accurate to 0.02 millivolts. The dual input is equipped with an internal switch. The battery life is two years. $ 215.00

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For more information circle **95** on inquiry card.

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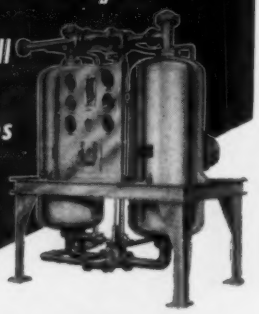

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For more information circle **97** on inquiry card.

NEW INSTRUMENTS

light-weight high-temperature resistors meeting MIL-R-10566. Hollow molded ceramic with resistance wire embedded within permits smaller diameters and weight reduction of nearly 25 percent. Units are rated at 350 C. hot-spot temperature.—*Shallcross Mfg. Co., Collingdale, Penna.*

For more information circle **354** on inquiry card.

MECHANICAL COMPONENTS

Power Cylinder

New "Power Drive" cylinder is available in 1½-, 2¼-, 3- and 4-in. bores; can be operated on 500 psi. max. oil or water, or 200 psi. on air, without interchanging or adding parts. Among features: lightweight construction; sealed-in lubrication; adjustable cushioning (optional); rod wiper and extra-long self-lubricating bronze bearing protect finish on piston rod; complete gland can be replaced without dismantling cylinder.—*Industrial Actuators and Controls Div., National Pneumatic Co., Inc., 125 Amory St., Boston 19, Mass.*

For more information circle **355** on inquiry card.

Power Cylinder

New air-hydraulic cylinder of unique co-axial design is said to "provide the smoothness and precise control of hydraulic power from any shop air supply." Air cylinder surrounds oil cylinder, obviating excessive length. Expanding exhaust air helps cool oil. Automatic models are available with built-in controls of speed, direction, fast traverse either direction, and automatic recycling. Standard models can be remotely controlled with conventional valving and piping. Thrust 3.14 × airline pressure; pull 2.7 × airline pressure; any stroke length to 72 in.—*Modernair Corp., 400 Preda St., San Leandro, Calif.*

For more information circle **356** on inquiry card.

Hose Adapters

New "SFG" connector adapter for re-usable "Hoze-lok" fittings for hydraulic hose has a swivel nut on one end and male pipe thread on the other; permits installation where otherwise direct mounting of male pipe thread hose fitting would result in twisting of hose.—*The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.*

For more information circle **357** on inquiry card.

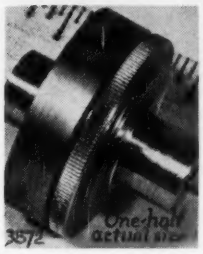
Hydraulic & Air Seal

New "Connealy Seal" fits into standard groove having recommended width to accommodate an O-ring and two back-up rings. Sealing is effected by interference at low pressure, but at high pressure a lip type of seal de-

velops as a result of pressure distortion of seal. Recommended primarily for difficult high-pressure applications.—*Sili-Craft Rubber Corp.*, 1700 *West 135th St., Gardenia, Calif.*

For more information circle **358** on inquiry card.

Miniature Slip Clutches

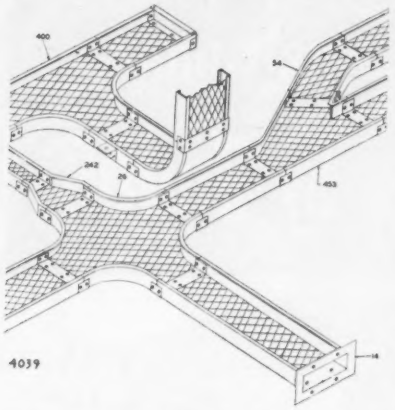


New miniature slip clutches control torque while permitting variation in speed between driving and driven mechanisms; are designed for long periods of slip without altering slip torque rating. These features are made possible by utilizing new principles. One series uses silicone putty as transmission material; second series utilizes principle of cantilever spring deflection. In both, accurate torque ratings can be maintained.—*Radial Metal Products, Inc.*, 1044 *Linwood St., Brooklyn 8, N. Y.*

For more information circle **359** on inquiry card.

Cable-support System

New "Cabletrof" saves time in drafting room and money in installation: comprises raceways of various



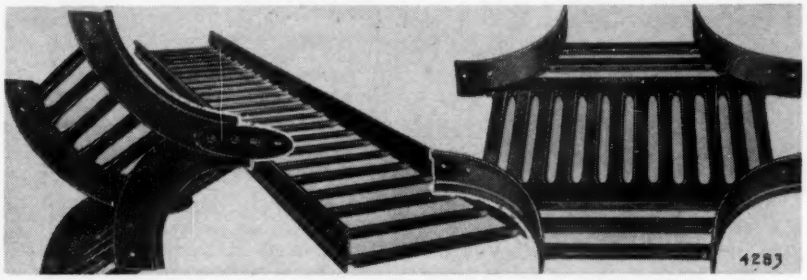
widths, runs at different levels and in any direction, over or around obstructions, etc.—*P-W Industries, Inc.*, 4500 *Melrose St., Philadelphia 24, Pa.*

For more information circle **360** on inquiry card.

Cable-support System

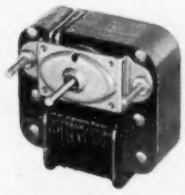
New "Globe Cable Way" modular-design system of cable and tubing raceways has all parts die-produced for uniform fit.—*The Globe Co.*, 4000 *S. Princeton Ave., Chicago 9, Ill.*

For more information circle **361** on inquiry card.



ELECTROMECHANICAL COMPONENTS

Instrumentation Motors



New "YAF" unidirectional small motors combine high starting torque with exceptional power output; are available in three stack thicknesses and nine power ratings from 1/200 to 1/40 hp. Among features: alignable oil-impregnated porous bronze bearings, selection of mounting arrangements.—*Small Motors Div., Barber-Colman Co.*, 1200 *Rock St., Rockford, Ill.*

For more information circle **362** on inquiry card.

Miniature Motor

New "Model 1600-1" permanent-magnet d-c. motor is designed as a drive motor for switches, cams, servos, etc. Weight 5½ oz.; motor diam. 1⅛ in.; length 2-7/16 in.; gear case diam. 1½ in.; mounting flange diam. 2½ in. May be designed for any input voltage of 6 to 30 v.dc. and for any output speed from 4 to 10 rpm. Maximum torque at 4 rpm. is 50 oz.-in.—*El Ray Motor Co., North Hollywood, Calif.*

For more information circle **363** on inquiry card.

Self-cooled Servomotor

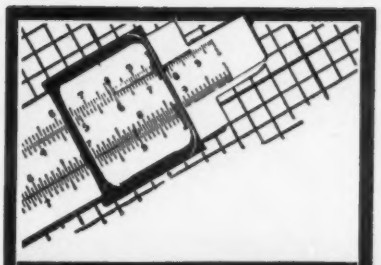
New "Series 5100-2237" is said to pack an unprecedented amount of power for its size: weighs 3.188 lbs., yet develops 1/15th hp. at 6000 rpm. and

has 22 oz.-in. stall torque. Overheating is prevented by a blower which functions independently. Acceleration is 31,000 radians/sec.^{2} minimum; rotor inertia is 50 g.cm.^{2} maximum.—*Avionic Div., John Oster Mfg. Co., Racine, Wis.*

For more information circle **364** on inquiry card.

Motor-alternator

New "Model HA-2" 2-phase 30-cps. 18-v. motor-alternator has rotor shaft extended at both ends to permit unit to perform several functions simultaneously. Power output 2.7 watts from shaft and 1.37 watts of electric



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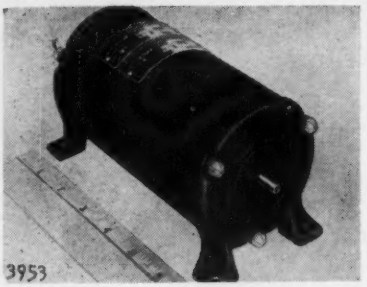
NEW INSTRUMENTS

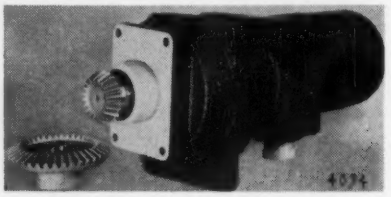


power. Input 115 v.ac., 26 to 30 watts; weight 6 lbs.★ "Model HA-1" similar but 120-cps. input and 60-cps. output. —*Electric Motors and Specialties, Inc., Garrett, Indiana.*

For more information circle **365** on inquiry card.

Electric Power Unit

New "Rotary Actuator" is a 0.7-hp. unit, 200 v., 400 cycle, 3 phase. Locked



rotor torque 12 lbs. with 11,200 rpm input and 38 rpm output, 7 amps. continuous duty. Rotation 330 deg.— *Western Gear Works, P. O. Box* 182, *Lynwood, Calif.*

For more information circle **366** on inquiry card.

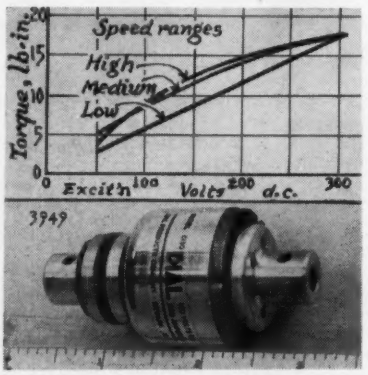
Flange-ring P-m Motor

New "Type PM-36" 27-v.dc. p-m. motor, for quick assembly-line handling, offers a flange-ring mounting for quick attachment by clamps or retaining rings; provides 20-watt output at 6,000 rpm. continuous duty.— *Dalmotor Co.,* 1342 *Clay St., Santa Clara, Calif.*

For more information circle **367** on inquiry card.

Magnetic Clutches

New "Model C-130," said to be the most compact and lightest (0.34 lb.) stock unit on the market, allows misalignment of driving and driven

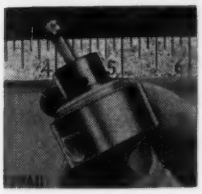


shafts, draws 3 watts max.; has exceptional characteristics (see curves); max. speed 4000 rpm.—*Dial Products Co.,* 55 *Evergreen Ave., Newark* 5, *N. J.*

For more information circle **368** on inquiry card.

VALVES

Toggle-actuated Valve



New toggle-actuated "Demi" valve is available in bronze, aluminum, steel or stainless steel body with a neoprene diaphragm in all cases; bonnets as shown or threaded on OD for panel mounting. Can also be furnished in "Model TV-3." (Toggle-actuated 3-way valve with a Vent to atmosphere). Have been tested on air pressure up to 500 psi.—*George W. Dahl Co., Bristol, R. I.*

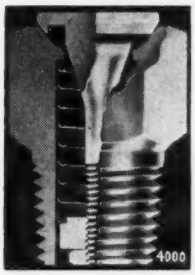
For more information circle **369** on inquiry card.

Hand & Foot Air Valves

New improvements have been made in operating mechanisms of both 3-way and 4-way models of maker's "880 series," available with single foot treadle, double foot treadle, vertical hand lever or horizontal hand lever controls.—*Ross Operating Valve Co., Dept.* 1506, 120 *East Golden Gate, Detroit* 3, *Mich.*

For more information circle **370** on inquiry card.

Relief Valve

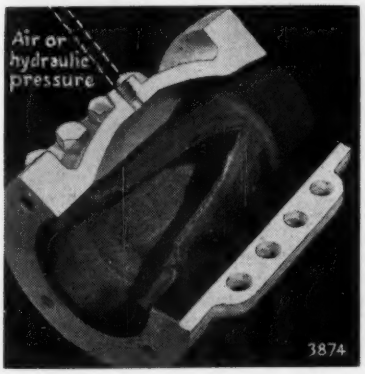


New pop-off relief valve seals tight with no leakage below release pressure and reseats dead tight within 10 percent of this value. Resilient member fitted into poppet head seats into a spherical section in body. Spherical valve seat obviates need for close stem alignment. Available for pressures to 125 psi.—*James-Pond-Clark,* 2181 *E. Foothill Blvd., Pasadena* 8, *Calif.*

For more information circle **371** on inquiry card.

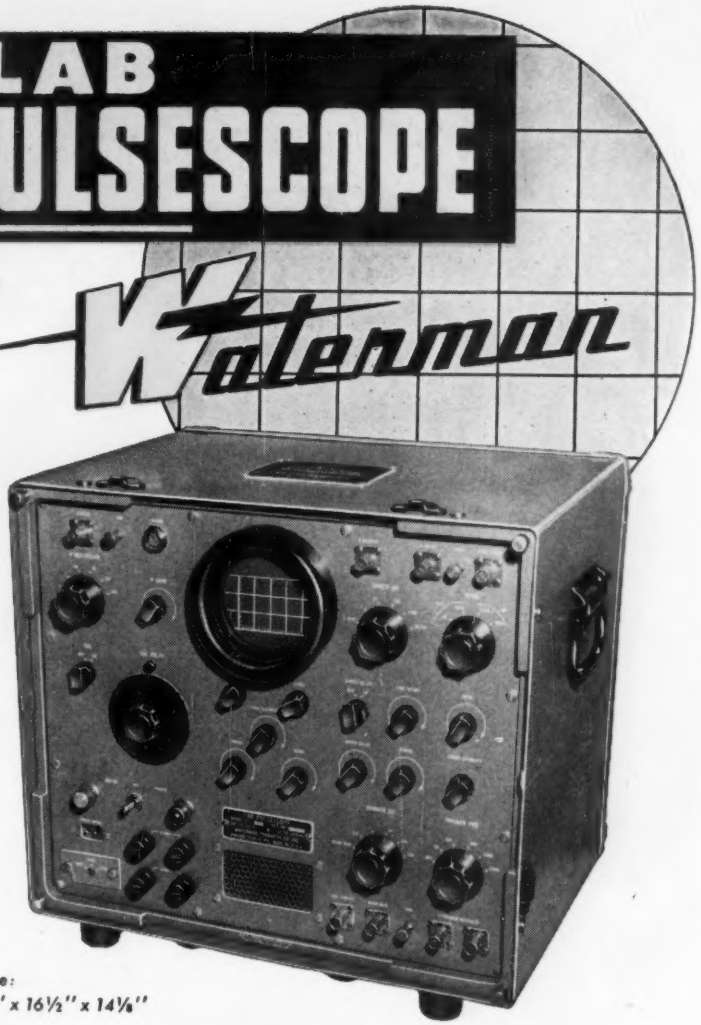
Squeeze-type Valve

New "Red Jacket Valve" is a new type of control valve for handling solids in suspension, acid slurries,



LAB PULSESCOPE

by Waterman



MODEL S-5-A

Size: 13" x 16½" x 14⅛"

ANOTHER EXAMPLE OF Waterman PIONEERING...

The LAB PULSESCOPE, model S-5-A, is a JANized (Gov't Model No. OS-26) compact, wide band laboratory oscilloscope for the study of all attributes of complex waveforms. The video amplifier response is up to 11 MC and provides an equivalent pulse rise time of 0.035 microseconds. Its 0.1 volt p to p/inch sensitivity and 0.55 microsecond fixed delay assure portrayal of the leading edge when the sweep is triggered by the displayed signal. An adjustable precision calibration voltage is incorporated. The sweep may be operated in either triggered or repetitive modes from 1.2 to 120,000 microseconds. Optional sweep expansion of 10 to 1 and built-in markers of 0.2, 1, 10, 100, and 500 microseconds, which are automatically synchronized with the sweep, extend time interpretations to a new dimension. Either polarity of the internally generated trigger voltage is available for synchronizing any associated test apparatus. Operation from 50 to 400 cps at 115 volts widens the field application of the unit. These and countless additional features of the LAB PULSESCOPE make it a MUST for every electronic laboratory.

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NEW!

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5070

INTERNAL SAFETY VALVE

A quick closing emergency shut-off valve designed to automatically cut off flow out of tank in case of fire. Valve is spring-loaded and is held in open position by a fusible link which melts at 160°F. When this link melts, spring action completely closes the valve.

New features include:

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2. VACUUM BREAKER INCORPORATED IN PALLET FOR EASE OF OPENING.
3. OPERATING LEVER LINKAGE ARRANGED FOR POSITIVE MANUAL SHUT-OFF.
4. VALVE SEAT FACED WITH STAINLESS STEEL TO RESIST CORROSION.

Standard construction is steel body with bronze valve disc. May be mounted on standard A.P.I. or VAREC Fig. No. 308 Series Tank Shell Nozzles. Available with Series 15 or Series 30 Flanges. Available sizes: 4" x 6", 6" x 8", 8" x 10", 10" x 12" and 12" x 14".

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For more information circle **101** on inquiry card.

NEW INSTRUMENTS

etc. Body is cast iron; sleeve pure gum rubber, butyl or neoprene. Pressure command from instrument can be put directly to valve body for low-pressure lines or through a booster relay for high-pressure lines.—*Red Jacket Co., Inc., Investment Bldg., Pittsburgh 22, Penna.*

For more information circle **372** on inquiry card.

MISCELLANEOUS

Pellet Arrester Cap

New insulating cap for distribution arresters, smaller than previous porcelain caps, is made of molded polyester glass; in test proved more than seven times stronger than porcelain; has a high dielectric strength and arc resistance (in excess of 30 kv. or twice highest arrester rating).—*Distribution Transformer Dep't, General Electric Co., Pittsfield, Mass.*

For more information circle **373** on inquiry card.

Network Transformer

New vault-type network transformer has radiator designed for strength and ease of cleaning and repainting; box structure stiffens tank wall and facilitates cleaning and repainting by leaving free space between tank and tubes; corrosion problems are minimized.—*Distribution Transformer Dep't, General Electric Co., Pittsfield, Mass.*

For more information circle **374** on inquiry card.

Ten-way Wrench

New "Inca Quickie Wrench" accommodates 95 percent of all nuts and

bolts up to 19/32 in. wide, in ten different sizes. Small head enables use in inaccessible areas.—*The J.E.S. Co., 111-49 Lefferts Blvd., South Ozone Park 20, L. I., N. Y.*

For more information circle **375** on inquiry card.

Cable-fastening Tool

New one-hand automatic stapler enables "Romex" and non-metallic cable to be speedily fastened (also copper

tube lines). Gun shoots a heavy staple with every squeeze of trigger; not only saves materials but serves as a safety measure for fingers and tempers.—*The Heller Company, 2153N Superior Ave., Cleveland 14, Ohio.*

For more information circle **376** on inquiry card.

Books...

SYMPOSIUM ON FLUORESCENT X-RAY SPECTROGRAPHIC ANALYSIS

American Society for Testing Materials, 1916 Race St., Phila. 3, Pa., 1954. Paper, 72 pages, $1.75.

Six chapters present basic theory and fundamentals of fluorescent x-ray spectrographic analysis, use of multichannel recording, examination of metallic materials, analysis of minerals, analysis of stainless steel, and correlation between intensity and chemical composition.

MAGNETIC AMPLIFIERS

Herbert F. Storm

John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Cloth, 546 pages, $13.50.

Twenty nine chapters, college level, cover basic subjects of magnetics, magnetic amplifier theory, components, applications, and saturating reactors. Includes static characteristics, transient response, feedback, Amplistats, cores, etc.

FASTENING ELEMENTS IN PRECISION MANUFACTURING

(Verbindungselemente der Feinwerktechnik)

Hermann Poeschl

Springer-Verlag, Berlin W. 35, Germany, 1954. Paper, 108 pages, 13.50 DM.

The various devices and methods used for joining parts are illustrated (741 figures) and described.

PROCESSING AND SHAPING FOR CORRECT USE OF THE MATERIAL IN PRECISION DEVICES

(Fertigungs-und stoffgerechtes Gestalten in der Feinwerktechnik)

Karl-Heinz Sieker

Springer-Verlag, Berlin W. 25, Germany, 1954. Paper, 166 pages 21.00 DM.

Construction and methods are well illustrated with examples.

A PRACTICAL MANUAL OF MEDICAL AND BIOLOGICAL STAINING TECHNIQUE

Edward Gurr

Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 1953. Cloth, 320 pages, $4.00.

Six sections, undergraduate level, cover fixation, normal and pathological animal histology, botanical methods, cytological methods, fluorescence microscopy and smear preparations.

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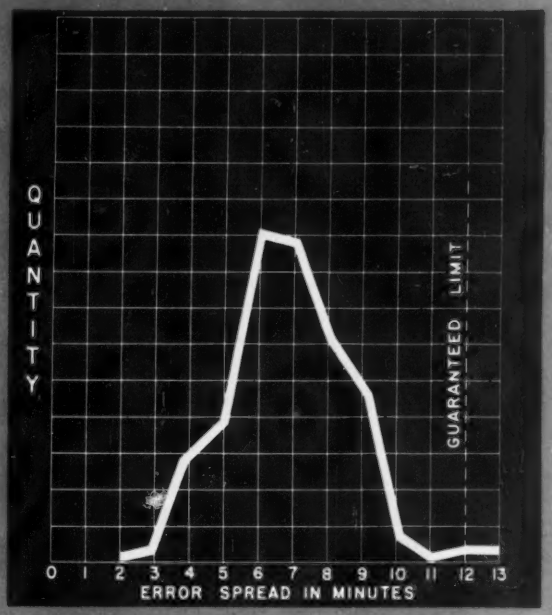

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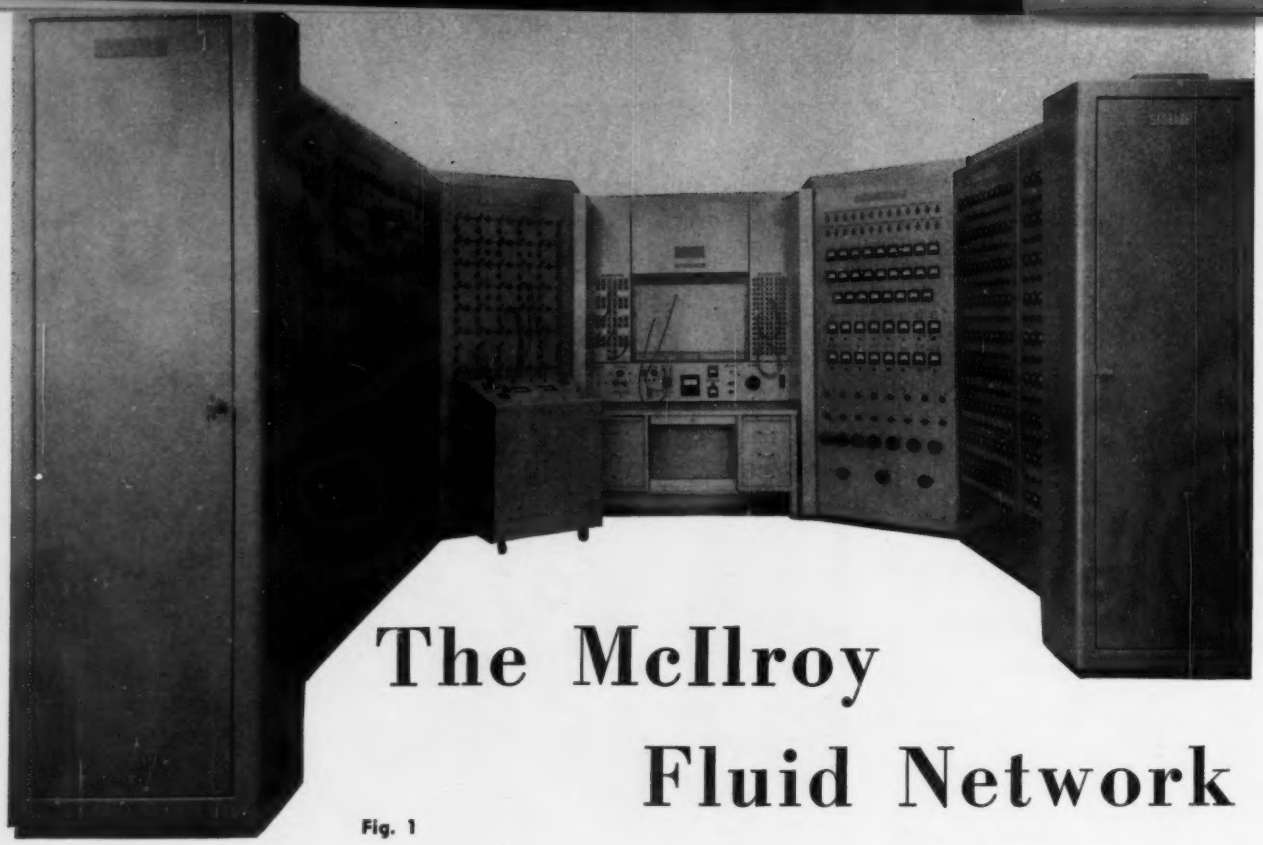

The McIlroy Fluid Network

Fig. 1

Fluistors simulate pipelines in the McIlroy Network Analyzer, a versatile device for rapid design of networks, expansion of flow systems, and modification of complex systems.

ROBERT C. MOORE
Standard Electric Time Co.

McILROY FLUID NETWORK ANALYZER is an analog computer designed for studying the pressure and flow rate of fluid flowing in networks of pipes or ducts. The analyzer has been used for studies of municipal and industrial water systems, natural and manufactured gas systems, airways in coal mines, steam distribution systems, and oil pipeline networks. It was invented by Dr. Malcolm S. McIlroy, Professor of Electrical Engineering at Cornell University, and is manufactured and sold by The Standard Electric Time Company.

In many fluid systems the relation between pressure drop along a pipeline and the rate of fluid flow through it may be expressed by the general equation:

$$P_1 - P_2 = Ak_pQ^n \qquad (1)$$

for a fluid of constant density, or

$$P_1^2 - P_2^2 = Ak_pQ^n \qquad (2)$$

for a fluid of variable density, such as high-pressure gas. (P_1 and P_2 are input and output pressures respectively of the fluid flowing in the pipeline; Q is the flow rate; k_p is a constant whose value depends upon the length, diameter, and condition of the pipeline; A is a factor to adjust for the system of units used; and n has values ranging from 1.7 to 2 in various flow formulas.)

Fluistors

In the electrical analogy, pressure drop or the difference in squares of pressure are represented by voltage, fluid flow is represented by direct current (in amperes), and pipelines are represented by nonlinear resistors called *Fluistors*. The Fluistor is a resistive device whose current-voltage characteristic is given by the equation:

$$V = kI^{1.85} \qquad (3)$$

in which V is the voltage drop across the resistor, k is the coefficient of the resistor, and I is the current through the resistor in amperes. A comparison of equations (1), (2) and (3) reveals an automatic electrical analogy that can be used throughout the normal range of values of n.

An acceptable resemblance between a 1.85-power curve and a square-law curve may be achieved if the two curves intersect at the expected average value of pressure drop per pipe, or at the average difference in pressures squared per pipe. The calculation of each Fluistor coefficient involves the average value assumed. Increased accuracy may be obtained by modifying the Fluistor coefficient of pipes whose pressure drop is greatly different than the expected average value.

Each analyzer is equipped with a stock of Fluistors with individual coefficients from 0.058 to 240, in increments of approximately 5 percent. As these resistors may be used in series and parallel combinations as well as individually, a large range of pipe diameters and lengths may be represented.

Sources and Loads

Fluid systems contain sources and loads, in addition to pipelines. Sources such as pumping stations are represented on the analyzer by rheostats adjusted to proper voltage (input pressure) and fed by direct current from either a motor-generator set or a rectifier. Loads are represented by electronic circuits which control the desired constant currents (fluid outputs) leaving the pipeline network, regardless of the voltages (pressures) available.

Fig. 1 shows the analyzer of the Laclede Gas Company, St. Louis, Mo.

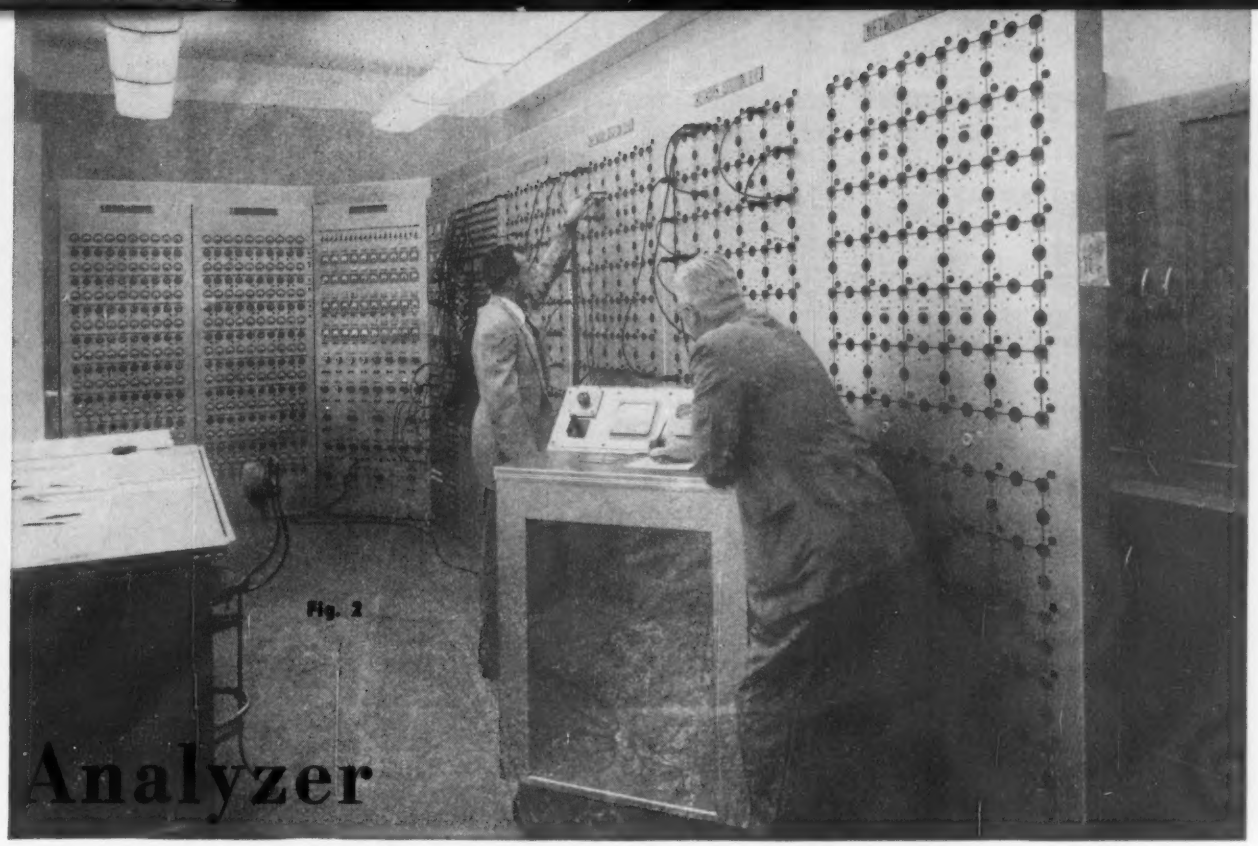

Fig. 2 (and the front cover) shows the McIlroy analyzer owned and operated by the Public Service Electric and Gas Co. of Newark, N. J. The panels from left to right include 2 load panels containing 180 electronic load units, a source panel with 20 source circuits and 12 auxiliary rheostats, a control panel, a patch panel, and 4 network panels with a total capacity of 568 Fluistor sockets. The rolling cart contains master meters and other test equipment.

System Mapping

The first step in most analyses is to prepare a map of the system showing locations of pipelines, sources, loads, and other pertinent features. Pipeline constants are computed according to the appropriate equation, and known data are compiled about sources and loads.

Conversion factors are selected to relate fluid quantities to analogous electric quantities. By simple computations, flow rates at various loads are converted to amperes, source pressures are converted to volts, and pipeline constants are converted to Fluistor coefficients. Values of these quantities are recorded on a schematic diagram used to connect and adjust the analyzer. Fluistors are inserted on the network panel, and sources and loads are connected to network intersection points on the patch panels.

Fluistors are inserted on the rear of the network panel. Fluistors of all coefficients glow with equal brightness at equal voltages. The pipes with higher pressure drops will be represented by the brighter fluistors or by series combinations of fluistors. A visual inspection will often reveal the points of highest pressure drop in the system before any actual measurements are made. Mirrors have been used to allow observation of the Fluistors from the front of the analyzer. The larger units are generally operated by two men, allowing one to observe Fluistor glow directly whenever it is desirable.

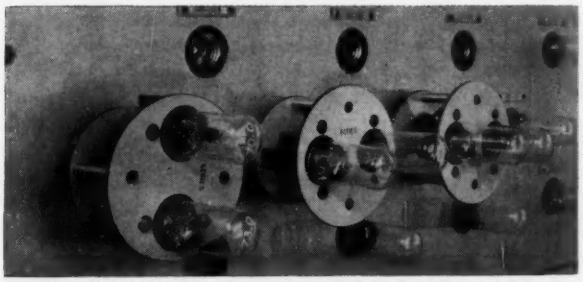

Fig. 3. Fluistors inserted on rear of network section. Adapter is for parallel combinations.

After generator voltage, load currents, and source voltages are adjusted to meet known conditions, the analysis of the system is begun.

System Analysis

By inserting the master ammeter in series with each Fluistor the flow rate of fluid in the analogous pipeline may be read directly from a demountable scale on the ammeter face. Pressure drop may likewise be read directly by connecting the master voltmeter, equipped with demountable scale, across any desired portion of the pipeline network. When source pressures and load flows are known, the analyzer is used to determine the flow rate of each source, and the pressure at which each load is delivered. As direct current is used, the direction of each pipeline flow is determined by the polarity of ammeter and voltmeter readings. Some McIlroy analyzers are equipped with map panels on which pressures may be measured through an overlay drawing of the system.

In many studies various combinations of physical layouts and operating conditions are analyzed. After the basic system is set up on the analyzer the results of modifications are obtained rapidly. The analysis is a direct analogy process.

The analyzer has been used for designing, operating, and reinforcing pipeline networks. Required changes in the existing portions of expanding systems oftentimes must be determined, in addition to the design of facilities in new outlying areas. The necessity for economic operation and high quality service to system users justifies the increasing use of the McIlroy Fluid Network Analyzer.

The Automatic Factory—

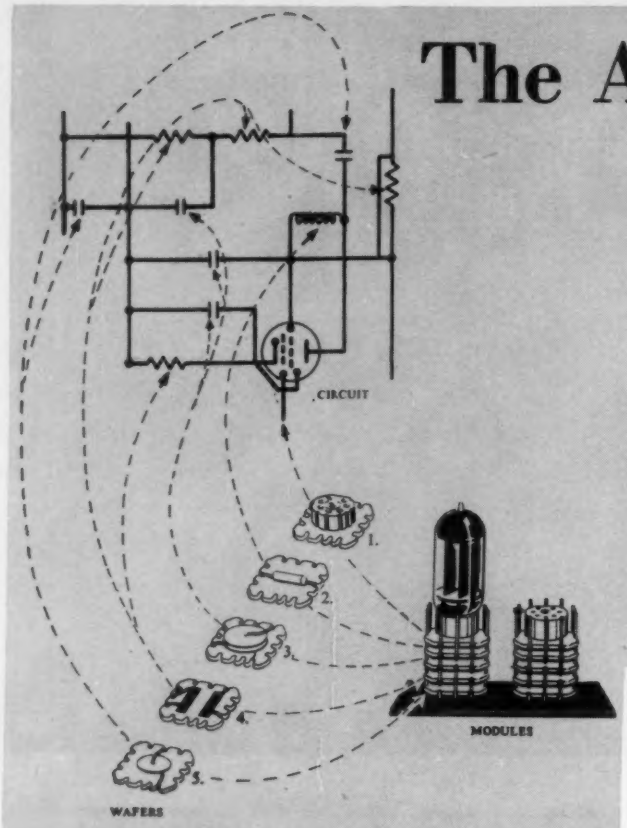

Fig. 9-1. Principle of Tinkertoy module construction.

Project Tinkertoy illustrates revolutionary manufacturing techniques associated with complete redesign of product for automation. This detailed report on cost comparisons of conventional vs. Tinkertoy hand and Tinkertoy machine techniques shows all the factors that enter into the cost-determination analysis.

PROJECT TINKERTOY (Fig. 9-1) is the code name of a new system for manufacturing electronic circuits. It was conceived and developed by the National Bureau of Standards and sponsored by the U. S. Navy Bureau of Aeronautics.

The unique basic component of Project Tinkertoy is the ceramic wafer. It provides the base onto which the major portion of the circuitry is printed. This silver-paint-base circuit is affixed by heat, which is a principal reason for the use of ceramics. The wafer rigidly supports, and has attached to it, electronic elements such as resistors, capacitors, sockets, and tubes.

Tiers of up to six such wafers, each printed and electronically equipped, are assembled together into rigid module structures by 12 vertical riser wires (3 per edge) which provide structural strength and connect the circuitry of adjacent wafers. These module assemblies constitute the intrinsic core of the Tinkertoy concept.

The Project Tinkertoy system of manufacture is applicable to hand or machine methods, and is particularly adaptable to automatic machine production.

Objectives of Survey

Electronic equipment manufactured thus far by Tinkertoy methods has been processed largely on a pilot plant and model shop basis. The objectives of this survey are (1) to determine the cost of manufacturing a specific item of electronic equipment by Tinkertoy hand and Tinkertoy machine processes, and (2) to compare these costs with the cost of manufacturing a similar item by conventional methods and practices.

The cost figures for machine processing were necessarily based largely on estimates for net machine yields, and are subject to revision as operating experience is gained. The cost figures for hand processing are based to a large extent on time studies of operations. They are, therefore, less subject to revision.

The objectives outlined have been accomplished by (1) analyzing the Project Tinkertoy hand and machine processes to determine process flow, and delineating the individual steps, (2) developing costs for hand and machine processes, individual hand and machine manufactured modules, and the complete item manufactured by the Project Tinkertoy hand and machine processes, and (3) obtaining costs for the selected item as manufactured by conventional methods.

Project Tinkertoy Process Flow

The process steps for the Tinkertoy hand and machine processes are substantially the same, though certain steps are used in one and not in the other. Fig. 9-2 illustrates the sequence and relationship of these process steps.

Process operations are enclosed in solid lines. Dotted-line enclosures indicate parts flow.

Process designations are indicated in the boxes adjacent to the process descriptions and are explained in the "Legend" portion of the chart. The omission of a process designation for either a hand or a machine operation indicates the particular step is not performed in the hand or the machine process, as the case may be.

Selection of Item

The item selected for the cost comparison was a conventional 9-stage Intermediate-Frequency Amplifier. This unit is similar to interchangeable sub-assemblies which are incorporated into a variety of complete electronic assemblies. It will be referred to as an IF Amplifier throughout the report.

The component modules of the IF Amplifier have been produced by Tinkertoy processes only in a four-wafer design, and only by hand. These particular four-wafer layouts were not adaptable to machine assembly. Five-wafer modules, adaptable to machine assembly, were therefore laid out for costing purposes. They were carefully checked for electrical correctness. Although these module layouts have not been built, similar modules have been built and tested. It is considered, therefore, that no

A Critical Examination

STEPHEN A. JUNE
JOHN D. BARDIS
LEE H. LURIO
LEONARD S. POLANER
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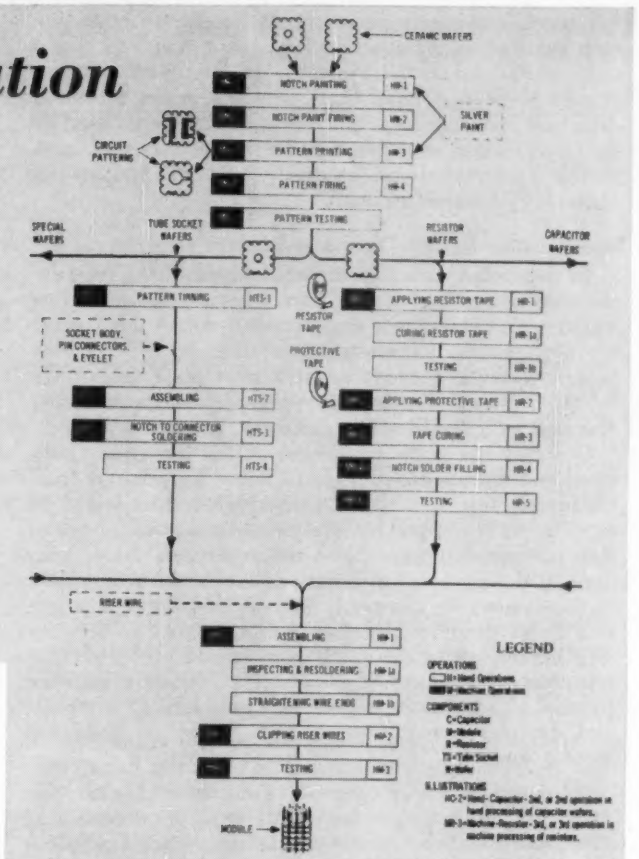

Fig. 9-2. Unit step operations for hand (H) and machine (M) operations.

significant error will result from using these module layouts for cost-comparison purposes.

Establishment of Costing Basis

The sales price of an object is normally composed of the following major cost elements:

1. Profit
2. Sales and Administrative Expense
3. Manufacturing Costs
   a. Materials
   b. Direct Labor
   c. Manufacturing Overhead
      (1) Indirect Labor
      (2) Machine, Equipment, and Tool Expenses
      (3) Occupancy Expense
      (4) Miscellaneous Expenses

It was decided to use the Manufacturing Cost element of the sales price as the basis for comparing costs for Project Tinkertoy because (1) manufacturing cost is the element of cost on which the other cost elements are based and (2) manufacturing cost figures can be compared readily with similar cost figures throughout industry, and can be adjusted for any specific set of operating conditions.

Standard Costing Rates

In determining the direct labor and manufacturing overhead costs, the representative rates and ratios shown in Table 9 were used. The percentage of overhead expenses apportioned as fixed costs for use in determining breakeven points between hand and machine processes are also shown in Table 9.

Determination of Manufacturing Costs

The projected Manufacturing Costs for Project Tinkertoy, consisting of the major cost elements—Material, Direct Labor, and Manufacturing Overhead—were determined as follows:

Materials Costs

The development of costs for these materials was complicated by (1) the relatively high cost of certain parts such as the ceramic wafers as now produced in small quantities at the pilot plant, (2) the necessarily small-order quantities for some parts, resulting in comparatively high prices, and (3) the fact that certain parts, such as base strips, have been handmade for this particular IF

Table 9.—Manufacturing-Cost Standard Rates

Item	Operations Rate or Ratio Machine	Operations Rate or Ratio Hand	Distribution Percent of Fixed Cost
1. WAGE RATES			
a. Highly skilled	$2.40	2.40	——
b. Skilled	2.00	2.00	——
c. Semi-skilled	1.60	1.60	——
d. Unskilled	1.20	1.20	——
2. FACTORY OVERHEAD			
a. Indirect Labor (% of direct labor cost)	30%	30%	30%
b. Machine, equipment, tool cost			
1. Annual Depreciation	10%	10%	100%
2. Interest charged on capital required	4%	4%	100%
3. Annual taxes and insurance	1%	1%	100%
4. Maintenance (% of equipment cost)	Avg. 20%	5-15%	25%
5. Utilities			
a. Electricity	.02/KW Hr.	.02/KW Hr.	——
c. Occupancy expense			
1. Ratio of Total Space to process space	6/1	5/1	——
2. Annual Rental/ sq. ft.	$1.00	$ .80	100%
3. Annual Heat/ sq. ft.	.10	.10	75%
4. Annual Light/ sq. ft.	.30	.30	10%

Amplifier, making it necessary to determine costs for such parts when manufactured in quantities.

All parts used in the Tinkertoy IF Amplifier are considered to be purchased parts, and the prices for these parts and materials were $35.85 for the materials used in the conventional assembly, $20.56 for the materials used in the Tinkertoy Hand assembly, and $20.56 for the Tinkertoy Machine assembly.

Direct Labor Costs—Tinkertoy Machine Process

To determine direct labor requirements for Tinkertoy machine processing, it was first necessary to determine machine and equipment requirements. All of the Tinkertoy components manufactured to date by the machine process have been produced at a pilot plant established by the National Bureau of Standards, and now being operated by a commercial contractor.

Observations of the equipment during the survey indicated that the amount of machine delay, particularly from malfunctioning, was considerably higher than might be expected with comparable equipment in a more advanced state of development. Some improvements have been developed, however, which have not yet been incorporated in the present equipment. It was decided that equipment and direct labor requirements based entirely on the current operations of the pilot plant would not provide a representative picture of the Project Tinkertoy machine process. Consequently, net machine production (or yield), and equipment requirements were based on following assumptions:

Assumptions for Projecting Equipment Yields. The projected machine process yields used in determining direct labor costs are based on (1) use of new equipment substantially like the present, operated at substantially the present cyclic rates, and incorporating improvements which have been developed during operations to date, (2) machine delay time reflecting the present stage of development of the equipment and general industrial practices and conditions with respect to time required for machine set-up, malfunctioning, maintenance, and operator's personal time, and (3) reasonable estimates of processed wafers or modules rendered unusable and therefore rejected due to equipment malfunctioning.

The projected yields are generally higher than current experience would indicate, but are considered to be reasonable expectations based on the foregoing assumptions.

Equipment Requirements. The equipment requirements used in determining direct labor costs were based on (1) equipment yields based on the previous assumptions, (2) the machine capacities necessary to process the required proportions of the various wafer components, (3) the necessity for a fairly balanced production line in order to reduce economic loss from unused machine capacity, and (4) operation of the facility on a 2-8-5, or two-shift, 8-hour-shift, and five-day-week basis.

Production Line Balance and Facility Cost. The machine process yields developed from the foregoing are shown in Table 10, together with the basic cyclic rates, machine delay times, and percentages of rejects on which these data are based.

After developing the equipment yields, the production line was balanced by adding to the present pilot-plant operation the machines necessary to reduce to a minimum the total unused machine capacity consistent with a reasonable capital-investment requirement. This resulted in a facility equipped to produce 405 five-wafer modules per hour, with an unused machine capacity equal to approximately 17 percent of the total investment. The number of pieces of equipment required for this facility are shown in column 9 of Table 10.

The replacement cost of the equipment required for this 405 module-per-hour facility is shown in column 11. These costs were established by evaluation of purchase records and estimates of those familiar with the equipment.

Determining Direct Labor Costs. After establishing the equipment requirements, estimates were prepared of the number and skills of the operators needed, based on general industrial practice with similar equipments. These operator requirements are shown in columns 16 and 17.

Table 10.—Equipment and Direct-labor Costs for Tinkertoy Machine Process.

1 Operation No.	2 Equipment Description	3 Basic cyclic rate pcs/hr	4 Machine delay hrs/8 hrs	5 % Rejects	6 Net machine yield pcs/hr	7 Factor for I F Amplifier	8 I F Modules per hr. (6÷7)	9 Machines required 405mod/hr.	10 Machine replacement cost per Mach.	11 Total	12 Output items required per hr.	13 per hr.	14 Unused % (12-13)/12	15 Capacity Mach. Cost (11x14)	16 Number & Skills	17 Composite rate
MW-1	Notch Painter	1,714	2.5	10%	1,060	4.9										
MW-2	Notch Paint Firing --OPERATION PERFORMED IN CAP.BODY PATTERN OVEN(See MC-3) **						216	2	$13,500	$27,000	2,120	1,985	6.4%	$1,722	2-S,2U	$6.40
MW-3	Pattern Printer	750	3.0	5%	445	4.9÷5										
MW-4	Pattern Firing Furnace	2,143	3.0	-	1,339	4.7÷5										
MW-5	Pattern Tester	3,000	1.5	10%	2,194	4.7										
							----------OPERATION PERFORMED IN CAP.BODY PATTERN OVEN (SEE MC-3)--- **								
MR-1	Resistor Tape Applicator	1,500	2.0	5%	1,069	1.5	473	1	26,500	26,500	445	381	14.3%	3,812	1-S,1-SS	4.80
MR-2	Resistor Prot.Tape Applicator	1,500	2.0	5%	1,069	1.5	1,424	1	9,000	9,000	1,339	381	71.5%	6,439	& 1-U	-
MR-3	Resistor Curing Oven	1,200	-	-	1,200	1.5	467	1	17,000	17,000	2,194	1,904	13.2%	2,240	***	-
MR-4	Resistor Wafer Notch Tinner	579	1.75	10%	408	1.5										
MR-5	Resistor Assembly Tester	632	1.5	5%	488	1.5	713	1	12,000	12,000	1,069	608	43.1%	5,175	1-SS	1.60
							713	1	12,000	12,000	1,069	608	43.1%	5,175	1-SS	1.60
MC-1	Cap.Wafer Pattern Tinner	560	1.5	5%	432	3.2	800	1	9,000	9,000	1,200	608	49.3%	4,440	/	-
MC-2	Cap.Body Pattern Printer	1,000	2.0	10%	675	3.2	271	2	5,750	11,500	816	608	25.5%	2,931	2-U	2.40
MC-3	Cap.Body Pattern Oven	1,818	-	-	1,818	3.2	325	2	11,000	22,000	976	608	37.7%	8,295	2-SS	4.80
MC-4	Cap.Body Pattern Tester	2,143	1.5	5%	1,654	3.2										
MC-5	Cap.Body Pattern Tinner	550	2.0	5%	392	3.2	135	3	7,600	22,800	1,296	1,296	0 %	-	3-SS	4.80
MC-6	Cap.Assembler	359	2.5	5%	234	1.7	211	2	10,000	20,000	1,350	1,296	4 %	800	2-SS	3.20
MC-7	Cap.Notch Tinner	579	1.75	10%	408	1.7	284	2	9,000	18,000	1,818	1,296	28.7%	5,168	/	-
MC-8	Cap.Assembly Tester	632	1.5	5%	488	1.7	517	1	5,500	5,500	1,654	1,296	21.6%	1,190	1-SS	2.40
							123	4	7,600	30,400	1,568	1,296	17.3%	5,273	4-SS	6.40
MTS-1	Tube Socket Pattern Tinning--OPERATION PERFORMED IN CAP.WAFER PAT.TINNER(SeeMC-1)						138	3	27,500	82,500	702	689	1.85%	1,528	6-SS	9.60
MTS-2							239	2	5,750	11,500	816	689	15.6%	1,790	2-U	2.40
MTS-2	Tube Socket Assembler	240	2.5	5%	156	.9	287	2	12,000	24,000	976	689	29.4%	7,057	2-SS	4.80
MTS-3	Tube Socket Notch Tinner	579	1.75	10%	408	.9										
							----------OPERATION PERFORMED IN CAP.WAFER PATTERN TINNER (SEE MC-1)--------								
MM-1	Module Assembler	125	2.0	10%	84	.9	173	3	32,000	96,000	468	365	22.0%	21,277	2-S,2-SS	7.20
MM-2	Module Riser Wire	270	2.0	5%	192	.9	452	1	5,750	5,750	408	365	10.6%	606	1-U	1.20
MM-3	Module Tester	423	1.5	5%	327	.9										
							93	5	31,500	157,500	420	365	13.1%	20,625	10-SS	16.00
							213	2	14,500	29,000	384	365	4.9%	1,435	2-SS	3.20
							363	2	8,000	16,000	654	365	44.2%	7,070	2-SS	4.80
										$664,950				$114,049		

* HS - Highly Skilled
S - Skilled
SS - Semi-skilled
U - Unskilled

** Included in MW-1

*** Included in MW-3

/ Included in MR-2

/ Included in MC-2

Table 11.—Equipment Costs for Tinkertoy Hand Process.

Operation No.	Operation Description	Standard Dec. Hrs. Per Operation	Output in Pieces Per Hr.	No. Operators to make 400 Mod./Hr.	No. Work Stations Req.	Equipment Cost for Work Stations
MW-1	Wafer Notch Painting	.00880	114	17.248	17	$ 894.30
MW-2	Wafer Notch Paint Firing	.00044	2,273	.8624	(1)	224.40
MW-3	Wafer Pattern Printing (1 side)	.00091	1,099	.5460	1	9,902.20
MW-3	Wafer Pattern Printing (2 sides)	.00184	543	2.2080	2	--
MW-4	Wafer Pattern Firing	.00044	2,273	.8624	(1)	4,730.00
MC-1	Cap.Wafer Pattern Tinning	.00638	157	4.5936	5	937.75
MC-2	Cap.Body Pattern Printing	.00196	510	2.6656	3	7,422.80
MC-2a	Make Cap. Leads	.00055	1,820	.7480	1	100.10
MC-3	Cap.Body Pattern Firing	.00044	2,273	.5808	(1)	3,190.00
MC-4	Cap.Body Pattern Testing	.00176	568	2.3936	3	1,620.30
MC-5	Cap.Body Pattern Tinning	.00396	253	5.3856	5	937.75
MC-6	Cap.Body To Wafer Assembly	.01320	76	2.1120	2	1,008.70
MC-6	Cap.Body To Wafer Assembly	.00715	140	2.2880	2	--
MC-6	Cap.Body To Wafer Assembly	.00473	211	1.3240	2	--
MC-6a	Assemble Cap. Leads (1 side)	.00781	128	3.1244	3	474.93
MC-6a	Assemble Cap. Leads (2 sides)	.01408	71	6.7584	7	--
MC-6b	Sub-Assemble Cap.Bodies	.00974	103	1.9480	2	378.40
MC-6c	Apply Prot. Coating (1 side)	.00847	118	2.7104	3	334.40
MC-6c	Apply Prot. Coating (2 sides)	.01694	59	6.7760	7	--
MC-7	Cap.Wafer Notch Solder Filling	.00880	114	6.3360	6	315.49
MC-8	Cap.Wafer Assembly Inspections	.00286	350	3.8896	4	2,160.40
MR-1	Res. Tape Application (1 side)	.00432	232	1.9008	2	135.30
MR-1	Res. Tape Application (2 sides)	.00620	161	1.2400	1	--
MR-1a	Dry Res. Tape	.00044	2,273	.2816	(1)	1,540.00
MR-1b	Inspect	.00550	182	3.3000	4	596.20
MR-2	Prot.Tape Application (1 side)	.00488	205	1.3664	2	246.40
MR-2	Prot.Tape Application (2 sides)	.00783	128	2.5056	2	--
MR-3	Dry Prot. Tape	.00044	2,273	.2816	(1)	1,540.00
MR-4	Res.Wafer Notch Solder Filling	.00792	126	4.7520	5	937.75
MR-5	Res. Testing	.00550	182	3.3000	4	477.40
MTS-1	Tube Socket Pattern Tinning	.00589	167	2.1204	2	375.10
MTS-2	T.S. Parts to Wafer Assembly	.01276	79	4.5936	5	1,353.00
MTS-3	T.S.Wafer Notch Solder Filling	.01716	58	6.1776	6	1,395.90
MTS-4	T.S. Inspection	.00524	191	1.8864	2	358.05
MM-1	Module Assembly	.04235	24	16.5400	17	17,576.90
MM-1a	Inspect & Resolder	.01749	57	6.9960	7	373.42
MM-1b	Straighten Wire Ends	.00880	114	3.5200	4	200.20
MM-2	Riser Wire Clipping	.01716	58	6.8640	7	508.20
MM-3	Module Testing	.00275	364	1.1000	2	18,123.00
	Special Items	.05500	18	2.2000	4	201.65
	Final Assembly	.38500	2.6	15.4000	16	1,249.60
	TOTAL			162.0868	167	$81,819.99

The number of operators, and the wage rates shown on the Standard Rate Sheet (Table 9) were used to determine the machine-process direct-labor costs used in this survey.

Direct Labor Costs—Tinkertoy Hand Process

Most of the Tinkertoy components manufactured to date by the hand process have been produced in a model shop of the National Bureau of Standards. The major emphasis has been on development, rather than on production, and consequently the methods and worker pace are not equivalent to commercial practice. Direct-labor requirements derived solely from current hand operations would not provide a sound basis for cost comparisons with conventional commercial manufacture. Therefore, it was decided to time-study the individual manual process steps and to establish production rates per worker, based on general industrial conditions and practices.

The production rates per worker for the various hand process steps thus developed (Table 11) are considered to be applicable to the average industrial plant.

In order to provide a direct comparison with the projected Tinkertoy machine-processing operations, an equivalent Tinkertoy hand-processing facility was projected with a capacity of 400 modules per hour. The equipment costs for this facility are shown in Table 11.

Manufacturing Overhead Costs

The manufacturing overhead costs were determined as follows:

Indirect Labor includes plant supervision, clerical, shipping and receiving, quality control, material handling, janitor and watchman service, etc. The indirect labor expense was developed by estimating the wages and salaries of the personnel required to service commercial facilities similar to those projected for Tinkertoy hand and Tinkertoy machine processing. This expense, compared to the estimated total expense for direct labor, provided the 30 percent ratio shown on the Standard

Table 12.—Work Sheet for Calculating Machine and Tool Costs for Tinkertoy Machine Process.

Annual Equipment Costs Based on ___ Shifts and ___ Hrs. Operations

		Total	Fixed	Variable
1.	Depreciation			
	Replacement Cost of Item _____	xx	xx	xx
	Annual Depreciation Rate 10%	xx	xx	xx
	Annual Depreciation _____	____	100%	xx
2.	Interest charge for Capital required			
	Replacement Cost ____ x Rate % 4% =	____	100%	xx
3.	Taxes & Insurance	xx	xx	xx
	Replacement Cost _____ 1% =	____	100%	xx
4.	Maintenance _____	____	25%	75%
5.	Utilities KW Hrs. ____ x Rate .02 =	____	xx	100%
6.	Miscellaneous _____	____	____	____
	_____	____	____	____
	_____	____	____	____
	TOTAL COSTS	____	____	____
		xx	xx	xx

Rate Sheet (Table 9) and used in distributing indirect labor costs to the various process steps for both hand and machine manufacture.

Machine, Equipment and Tool Expense covers depreciation, interest charges for capital requirements, taxes and insurance, power consumption, maintenance labor, materials, and overhead for all machines, equipment, and tools used.

This expense was developed by using standard rates, as shown on the Standard Rate Sheet (Table 9) for depreciation, interest, and taxes and insurance, and applying them to the estimated replacement costs of equipment required. To this was added the estimated maintenance and power expenses for the equipment, to obtain the total. The work sheet used to develop this expense is shown in Table 12.

Occupancy Expense was determined by estimating the space requirements of the facilities needed for the various operations, and multiplying the space by the average rates for rent, heat, and lights, as shown on the Standard Rate

Table 13.—Work Sheet for Assembling Manufacturing Cost Data.

Processes _____ Mach. Hand No. _____

Equipment _____ No. _____

Based on ____ shifts, ____ hrs., hourly prod. ____ and annual prod. _____

Item	Annual Cost Total	Fixed	Variable
1. Material	____	xx	____
2. Direct Labor = Hrs. ____ x Rate ____ =	____	xx	____
3. Manufacturing Overhead			
a. Indirect Labor - 30% of Direct ____ =	____	____	____
b. Machine, Equipment & Rool _____	____	____	____
c. Occupancy =			
Proc.Space _____ x Ratio =	____	xx	xx
Rent _____ =	____	____	____
Light _____ =	____	____	____
Heat _____ =	____	____	____
Subtotal - a, b, and c.	____	____	____
d. Miscellaneous - 10% x Subtotal ____ =	____	____	____
Total - a, b, c, and d.	____	____	____
GRAND TOTALS	____	____	____

Table 14.—Comparison of Hand and Machine Process-step Costs.

(Direct Labor and Manufacturing Overhead)

Oper. No.*	Operation Description	Unit Cost	Annual Volume**	Unit Cost	Annual Volume**	Break-even Volume**
Basic Wafer Preparation						
W-1,2	Wafer Notch Painting & Firing	.0201	7,840	.00663	7,938	None
W-3,4,5	Wafer Pattern Printing, Firing Testing	.00498	7,200	.00842	7,614	None
Resistor Wafer Preparation						
R-1	Resistor Tape Applicator	.0235	2,400	.00477	2,430	None
R-2	Protective Tape Applicator	.0141	2,400	.00477	2,430	67
R-3	Tape Curing	.00152	2,400	.00141	2,430	1,930
R-4	Wafer Notch Solder Filling	.0174	2,400	.00707	2,430	30
R-5	Inspection	.0121	2,400	.0124	2,430	2,915
Capacitor Wafer Preparation						
C-1	Wafer Pattern Tinning	.0140	2,880	.00584	3,390	140***
C-2,3	Body Pattern Printing & Firing	.00717	5,440	.00612	5,184	2,179
C-4	Body Pattern Testing	.00392	5,440	.0028	5,184	219
C-5	Body Pattern Tinning	.00866	5,440	.00917	5,184	8,969
C-6	Body to Wafer Assembly	.082 /	2,880	.0327	2,754	101 /
C-7	Wafer Assem.Notch Solder Filling	.0192	2,880	.00674	2,754	None
C-8	Inspection	.0120	2,880	.0121	2,754	2,939
Tube Socket Wafer Preparation						
TS-1	Wafer Pattern Tinning	.0129	1,440	.00584	1,794	See C-1
TS-2	Parts to Wafer Assembly	.028	1,440	.0546	1,458	None
TS-3	Notch Solder Filling	.0375	1,440	.0063	1,458	None
Module Assembly						
M-1	Assembly	.0958	1,600	.1096	1,458	3,510
M-2	Riser Wire Clipping	.0375	1,600	.0212	1,458	204
M-3	Testing	.00928	1,600	.01325	1,458	None

* Preceded by "H" for hand processes, and "M" for machine processes.
** In thousands
*** For C-1 and TS-1 combined
/ For H-6, 6a, 6b, 6c combined

Sheet (Table 9). Note that a lower rental rate was used for hand-processing space than for machine-processing space, based on the general practice of using more-expensive space for automatic-equipment installations.

Miscellaneous Expenses are numerous expenses incurred in connection with manufacturing facilities and operations, such as supplies, water and gas, employee benefits, loss and wastage, etc., for which it is difficult to establish general averages. However, it appeared reasonable to use a figure of 10 percent of the "Indirect Labor," "Machine, Equipment & Tool Expense," and "Occupancy Expense," to cover these miscellaneous expenses; this 10-percent figure is used throughout this manufacturing cost determination.

Assembling Cost Data

The Manufacturing Cost Data for each step of the Project Tinkertoy machine and hand processes were developed as outlined, and the data was assembled on work sheets illustrated in Table 13.

The distribution between fixed and variable expenses was made according to the percentages shown in Tables 9 and 12.

Process-Step Comparative Costs

Having developed complete manufacturing cost data, based on projected manufacturing facilities with capacities of 405 modules per hour for the Tinkertoy machine process, and 400 modules an hour for the equivalent hand process, a comparison of the manufacturing costs for each step in the machine process was prepared. These process-step costs per item processed are tabulated in the third and fourth column of figures in Table 14. The first and second columns are hand process steps. The lower of the two costs is underlined to facilitate comparison of machine and hand process-step costs.

For each machine process step, a chart was prepared depicting the *variation* between the manufacturing cost characteristics for the machine step and the comparable

Table 15.—Comparative Costs (Hand and Machine) for the 10 Modules of the IF Assembly.

Module	Direct Labor Hand	Direct Labor Machines	Manufacturing Overhead Hand	Manufacturing Overhead Machine	Totals Hand	Totals Machine
M-1	.46514	.1483	.16823	.1392	.63337	.2875
M-2	.50031	.2209	.19535	.27464	.69566	.49544
M-3	.51031	.2209	.19815	.27464	.70846	.49554
M-4	.62458	.23886	.22821	.29286	.85279	.53172
M-5	.55956	.23977	.22746	.29850	.78702	.53827
M-6	.51961	.21342	.18702	.26786	.70663	.48128
M-7	.52111	.2209	.19435	.27464	.71546	.49554
M-8	.63576	.28313	.23481	.30701	.87057	.59014
M-9	.63468	.25118	.24730	.27139	.88198	.52257
M-10	.40372	.18195	.16065	.23558	.56437	.41750
	5.375	2.219	2.042	2.636	7.416	4.856

hand process step(s). These cost-volume charts used the fixed cost overhead expense ratios referred to in Table 9.

Wherever the cost characteristics for a machine process step and its equivalent hand process step(s) converged and, therefore, would intersect, a break-even volume was thereby determinable at which the manufacturing costs for both processes are identical. These break-even volumes were determined by algebraic calculation, checked for correlation with the appropriate charts, and tabulated in Table 14.

Amplifier Comparative Costs

The manufacturing costs of the complete IF Amplifier were determined for both Tinkertoy hand and machine operations, based on the processing and materials costs shown, and on the final assembly costs.

Manufacturing costs for the conventional IF Amplifier were obtained from a Navy contractor who had produced a considerable quantity of the item. These costs, together with similar costs for Project Tinkertoy hand and machine processing, are tabulated in Table 16.

Conclusions

The significant conclusions of this survey are as follows:

Substantial reductions in electronic manufacturing costs appear to be possible through use of either Project Tinkertoy machine or hand processes, as compared with conventional manufacturing methods. Based on the survey projections, the manufacturing cost reductions amount to 44 percent for the Tinkertoy machine process, and 38.5 percent for the Tinkertoy hand process.

Manufacturing costs are lower for the Project Tinkertoy machine-processing operations than for the hand processes in 13 of the 20 process steps delineated in Table 14 and indicate 8.9-percent lower manufacturing cost for a complete IF Amplifier manufactured by Tinkertoy machine processes as compared to Tinkertoy hand processes.

Substitution of lower-cost hand process steps, where appropriate, would result in a lower total manufacturing cost for the IF Amplifier than the present projected machine-process total cost.

The $665,000 investment required for the projected 405-module-per-hour machine-process facility is aproximately 8 times the $82,000 investment for the 400-module-

Table 16.—Comparative Costs of Complete Amplifier

Method	*Materials*	*Direct Labor*	*Mfg. O.H.*	*Totals*
Conventional	$35.85	$5.60	$5.44	$46.89
Tinkertoy Hand	20.56	5.99	2.27	28.82
Tinkertoy Machine	20.56	2.83	2.86	26.25

per-hour hand-process facility, but the difference in investment would be repaid from manufacturing cost savings within less than one year and five months of operations at full capacity.

The Tinkertoy machine process uses fewer labor hours per unit produced than does the hand process, but requires a larger proportion of higher-skilled personnel.

Little, if any, manufacturing-cost reduction would result solely from an increase in size of the projected Tinkertoy hand or machine process facilities. (Some reduction in material costs might be expected from larger purchase order quantities.)

Significant reductions may be achieved in the present Tinkertoy hand-process costs through methods improvements in several of the process steps.

Significant reductions in the present Tinkertoy machine-process costs would result from (1) increases in equipment cyclic rates, (2) reductions in machine delay time, (3) reductions in percentages of rejects, (4) reductions in equipment costs, (5) reductions in numbers and skills of operators, or (6) reductions in equipment maintenance costs.

Appendix of General Terms

Automation: The application of automatic devices to manufacturing processes. It includes control techniques, material handling, and automatic assembly operations. Differentiation is often made between *process automation,* dealing with temperature, pressure, flow, density, etc., and *discrete-unit automation* dealing with time position and dimensions.

Automaticity: Same as automation.

Closed vs. Open Loops: A closed-loop control system is one which compares output with a predetermined standard and adjusts equipment to correct the deviations. Open-loop control systems do not use the output of the system to control the input to the system.

Cybernetics: An attempt to develop a theory on controls and communications common in humans and machines by comparing the functions of both.

Discrete Units: Separate, identifiable items of production as opposed to homogeneous free-flowing materials which are found in processing industries.

Feedback: The transmitting of the output signal back to the controller in a closed-loop system.

Integrated Handling: A system which not only transports parts between operations but also loads and unloads the machines.

Modularization: Designing products around basic standardized components. The manner in which these are combined will determine the finished product.

Printed Circuit: A method by which completely wired circuits are eliminated through depositing conductive material on ceramic or plastic insulation. This can be accomplished by die stamping, photoengraving, or silk screening.

System Engineering: The engineering of control systems by the examination of production variables to relate their behavior to the controls.

Control Terms

Computers: An electrical or mechanical calculator which can absorb, remember, and correlate information.

Mass Spectrometer: A device which analyzes and determines the exact chemical composition of materials.

Synchro: An abbreviation of "self-synchronizing," used to describe electrically connected machines, one of which (the "master") performs operations which are duplicated by the other ("captive").

Servomechanism: A feedback control system with either an electrical, pneumatic, mechanical, or hydraulic error signal and servomotor (final control element).

Tape Control: A control device which regulates a machine by either punched or sensitized magnetic tape.

Machinery Terms

Automatic Machine: A machine performing one or a sequence of jobs without alteration.

Automatic Indexing Machine: A machine where the cutting tools index to perform various operations.

Automatic Transfer Line: A joined group of multi-head, automatic machines. Manufacturers sometimes refer to the "line" as a transfer machine since it must be constructed as a unit.

Automatically Controlled Machine: A machine governed by a mechanism (usually servo) which assures a performance equal to predetermined standards.

Multi-head Machine: A machine which has more than one cutting tool or head operating simultaneously or in sequence.

Self-indexing Tools: A head with two or more cutting tools which will index automatically before (predetermined) or after a tool wears or breaks.

Transfer Machine: A multi-head automatic machine performing a sequence of operations on products which index forward from one station to the next.

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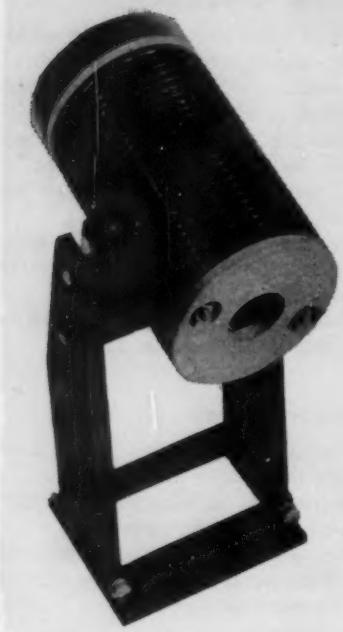
Watch for announcement . . .

THE AUTOMATIC FACTORY—

A Critical Examination

soon will be available in book form.



A BLACKBODY

In radiation pyrometry and infrared spectroscopy, the blackbody standard is a basic and versatile test standard. This temperature-controlled blackbody standard is based on the Mendenhall wedge. Typical applications are presented for calibration of bolometers and optical pyrometers, and measurement of total emissivity.

Fig. 1. Practical blackbody radiator.

GROWTH of infrared techniques in industry in recent years has been phenomenal. Industry after industry is discovering new uses for infrared radiation. For example, infrared has eliminated the need for many destructive analyses in the chemical industries; it has become an invaluable aid to law enforcement agencies for analysis of drugs, poisons, plastics, waxes, petroleum products, and organic substances in general; medical institutions and biological laboratories use infrared in research—for example, infrared was instrumental in the structure determination and synthesis of penicillin.

Production of total radiation pyrometers and infrared spectrometers has increased enormously in recent years. According to Professor Bryce Crawford[1], as of July, 1953, American manufacturers had produced over 1300 infrared spectrometers, and all within the last ten years. Infrared will have a marked influence on the automation of industrial processes because infrared analysis can accurately distinguish minute difference between substances.

The Theoretical Blackbody

Advances in infrared technique require exacting standards of radiation; the need for a commercially available "perfect blackbody radiator" is becoming more acute day by day. Such a radiator is important for comparison purposes because all laws governing thermal-emission sources are based on the temperature and spectral characteristics of the blackbody radiator.

A blackbody is a body that absorbs all the radiant energy incident upon it. As the radiant energy emitted by a blackbody is a function of temperature, the blackbody serves as a primary radiation standard and as a standard of comparison for other sources.

In general, blackbody radiation is independent of the properties of the particular material of which it is constructed. Hence, it can be shown[2] that a uniformly-heated cavity radiates a stream of radiation which must be the same in all directions. Furthermore, at any given temperature the radiation must be the same for all uniformly heated cavities.

As no material behaves like a blackbody, close approximations can be constructed in the form of cavities. The lower the emissivity of the walls of the cavity, the larger the length-to-diameter ratio must be. According to the calculations of Buckley[3], a cylinder of emissivity of 0.75 and a length-to-diameter ratio of 3.8 should display a blackness of 0.99; Andre Gouffe[4] calculated that a conical cavity of 15 degrees and an emissivity of 0.75 should result in an effective emissivity of 0.99.

1. *Scientific American*, October, 1953.

2. Richtmeyer and Kennard, *Introduction to Modern Physics*, 4th Ed., page 145
3. *Phil. Mag.*, Vol. 17, page 576, 1934
4. Revue D'Optique 24, Nos. 1-3, 1945

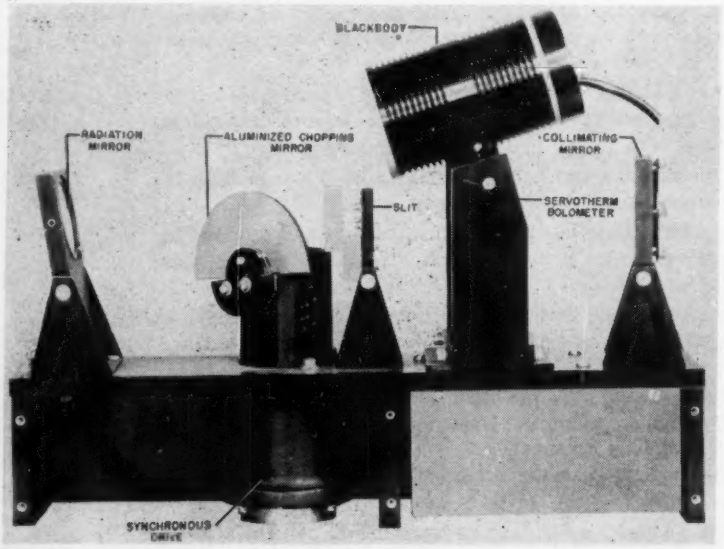


Fig. 2. Blackbody total-radiation unit, showing chopping mirror for modulating radiation from blackbody.

STANDARD

NORMAN MARCUS
Servo Corporation of America

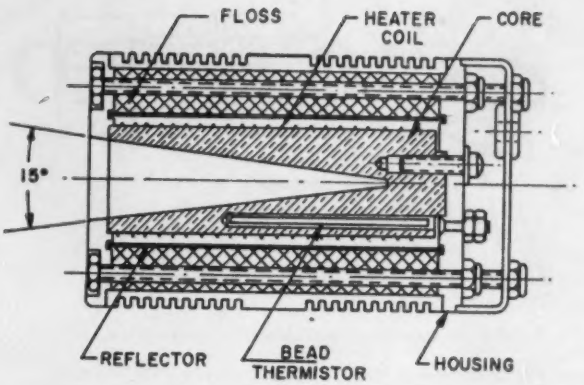


Fig. 4. Construction of blackbody radiator, showing Mendenhall wedge.

The primary consideration in constructing a blackbody of the cavity type is to provide a means for maintaining a precise temperature which is uniformly distributed along the walls of the cavity. Factors which weigh heavily in the choice of a suitable blackbody include simplicity of construction and operation, availability, and cost.

A Practical Blackbody

A practical blackbody (Fig. 1) was constructed and designed on the principle of the Mendenhall wedge. This blackbody radiator (Fig. 4) consists of a 15-degree conical cavity in a cylindrical copper block. The cylinder is bored at the opposite end to accept a bead thermistor which measures the cavity temperature. In order to reduce the heat losses, the end plates are made of transite.

A heater coil is wound about the threaded core. Insulation and a reflector minimize heat losses due to construction and radiation around the copper cylinder. When the radiator is carefully oxidized by heating, the copper core attains a total emissivity on the order of 0.7.[5] Hence, in accordance with the reference 4, the source approximates a blackbody radiator.

Baffles

No baffles were used. If it is desired to maintain the temperature of the aperture close to room temperature, the mounted radiator may be followed by a series of four separate baffles. The two baffle plates closest to the aperture would consist of transite; the other two would be aluminum sheets. The outermost aluminum sheet is painted black to prevent reflection of scattered energy.

A Typical Modulator

For modulating the radiation, a semi-circular aluminized mirror driven by a synchronous motor may be used (shown in Fig. 2 with complete optical system and detector). The mirror is mounted at 45 degrees with both surfaces aluminized; thus making it possible to compare some unknown source with the blackbody radiator.

The temperature of the blackbody radiator is continuously controllable from a few degrees above ambient to 350 deg. C. Temperatures as high as 500 deg. C. are attained with safety. These temperatures are controlled from a calibrated dial located on the panel of a precise electronic temperature controller.

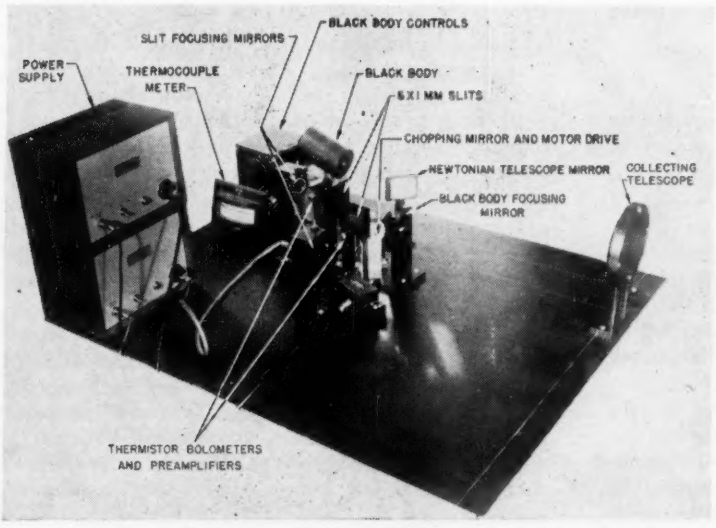


Fig. 3. Setup for measuring sensitivity of a bolometer.

Applications

An application of major importance for the blackbody radiator is in the determination of the blackbody sensitivity of a thermal detector. A laboratory set-up on a prototype blackbody is shown in Fig. 3. The radiator allows a known amount of

5. Handbook of Chemistry and Physics

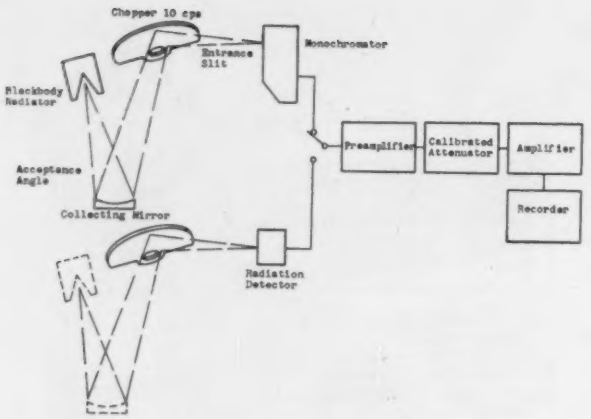


Fig. 5. Setup for measuring monochrometer transmission.

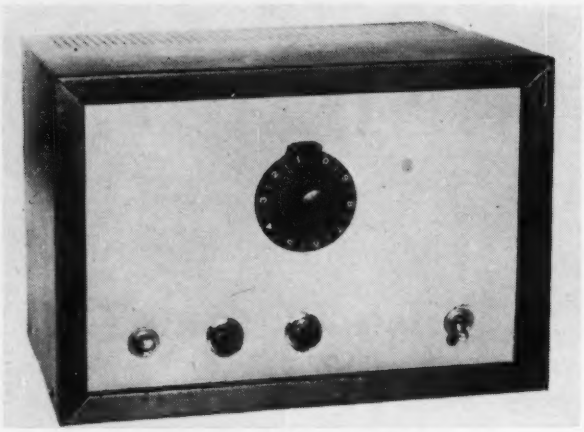


Fig. 6. Temperature controller.

blackbody radiation to fall upon the detector, whose response is observed and recorded.

The blackbody standard may be used as a reference for the analysis of the transmission and absorption characteristics of substances in the infrared region. When used in this manner the characteristics are independent of temperature because the radiator is relatively temperature stable. The radiator has many uses in spectrochemical analysis.

As a comparator, the blackbody radiator may be used as a standard for the determination of the temperature and spectral distribution of gray bodies and for establishing secondary standards.

It is often desired to measure the transmission of an infrared monochromator. To do this one must be able to measure the energy entering and leaving the monochromator under identical conditions. As shown in Fig. 5, this may be accomplished if the radiation detector is removed from the monochromator and placed at the entrance-slit position. The relative aperture of the collecting mirror must be such that all the energy emanating from this mirror falls within the acceptance angle of the monochromator. If this condition prevails, and if the signal voltages are set equal for each condition, then it can be shown that the monochromator transmission

$$T = (G_i/G_o)\ (A_B/aA_r)$$

where G_i = Gain setting on the attenuator when the detector is at the entrance slit

G_o = Gain setting on attenuator when detector is at the exit slit of the monochromator

A_B = Area of the detector

A_r = Area of the entrance slit

a = Fraction of the total radiant energy falling on the entrance slit for a bandwidth $\Delta\lambda$ at the given temperature.

Pyrometer Calibration

The blackbody is the only body for which the relation between the intensity of its radiant energy and the temperature is known theoretically. Hence, for calibrating pyrometers, the blackbody radiator can be an indispensible standard.

Like the blackbody, the pyrometer operates on the principles of the blackbody laws. By calibrating the pyrometer with a known blackbody, one can determine the temperature of any other blackbody by measuring its radiant flux for any wavelength interval or for the entire spectrum. The only requirement for calibrating the pyrometer is the setting of the blackbody to a number of definite temperatures.

If the substance whose temperature is to be measured is not a blackbody, its radiant energy may be represented by equation

$$W_n = e_t\ \sigma\ T^4$$

where e_t = total emissivity and T = true temperature in deg. K.

For a blackbody this energy

$$W_n = T_R^4\ \sigma$$

where T_R = radiation temperature in deg. K.

Then the radiation temperature is less than the true temperature by

$$T_R/T = (e_t)^{1/4}$$

From this it is possible to determine the relationship between T and T_R if e_t is known; or, if the temperatures are known, the e_t can be determined.

The applications cited are only a few of the problems which are of a general nature. Many other applications are found in industries which have problems that are peculiar to the industry itself, such as trace analyses in the cosmetic industry; the study of tissues, bacteria and biological samples in medicine; quantitative and qualitative analyses in the chemical industries; and numerous others.

Temperature Controller

The temperature controller (Fig. 6) is a high-gain closed-loop system which controls the temperature of the reference heat source within a fraction of a degree by continuously balancing a highly-sensitive thermally-controlled resistance bridge. In operation, the calibrated temperature dial adjusts one of the legs of the three fixed legs of the bridge, with the bead thermistor (in the blackbody radiator) serving as the fourth leg for balancing the bridge. The thermistor has a negative temperature-coefficient of resistance.

The nichrome heater element of the blackbody radiator is in the plate circuit of a thyratron current source which is controlled by the bridge.

The blackbody radiator and temperature controller were tested for performance. Approximately one half hour was required to raise the temperature of the blackbody radiator from ambient to 300 deg. C. Periodic temperature checks were made at a variety of temperatures using a Leeds & Northrup thermocouple bridge; at no time after the temperature stabilized did the temperature vary more than 0.2 degree; usually the temperature was within 0.1 deg. C. Line-voltage variations from 100 to 125 volts did not affect temperature.

An Economic Report on
AUTOMATION STOCKS

Financial investment advisers are asking their clients to consider one of the nation's fastest-growing industries—the automation industry.

Research Department
BACHE & COMPANY
36 Wall St., N.Y. 6, N.Y.

A SECOND industrial revolution—automation—has been gaining impetus in the United States. It may be described as "... the supplementing of man's senses and his brain power by devices which collect and process information, transmit it to the point needed and there either control machines or present the processed information to human beings for their use." It involves the automatic control of a continuous flow of a complete industrial process.

Automation is still in its infancy but, even now, a vast field of application can be foreseen. In industry, it will be used to meet increasingly competitive conditions. It is a logical development of American managerial skill which is known for mass production through the use of high capital investment per worker.

The automatic factory is based upon two developments:

(1) *Data processing equipment*: These may be analog type equipments which show results in non-numerical terms (such as lines on a chart) or digital equipments which show results in terms of numbers which can be recorded. These, in turn, are used to regulate

(2) *Automatic factory controls and the accompanying equipment*: The principle behind automatic control is known as "feedback," which is the return or feeding back of information about the output at one stage of production to an earlier stage so as to influence activity and alter the output itself.

Both the data processing equipment and the automatic controls make extensive use of electronics. To date, however, despite the miniaturization of vacuum tubes and other electronic devices, heat generation, failure of a tube, and size of equipment have been handicaps. Thus, the real potentials of automation are brought closer to realization by the development of solid-state electronics using the transistor. Work in this field is still in its early stages but the importance of electronics to automation cannot be underestimated.

The extent of the application of automation has, at present, no discernible limit. Oil refineries, for example, are theoretically capable of being under completely automatic control and, in fact, such operations have already been well advanced in this direction. In the automotive and other industries, intense competition is causing companies to place their operations on an automatic basis to an increasing degree. Indeed, in any field where capital investment is a major factor and cost control important, automation may be the key to success.

The use of data processing equipment, alone, has important applications in industry. It is being utilized to an increasing extent in office equipment, inventory control, and for retail and other accounting. It is revolutionizing engineering techniques through the speed and ability to solve long and involved equations which have been hindering research programs.

There are certain drawbacks to the application of automation which should be realized. Automation is generally best suited to high volume production of a uniform product. Installation of an automatic system usually necessitates a large capital expenditure. These factors suggest that automatic processes will be installed first by large companies with substantial financial resources.

Which Stocks?

The selection of those stocks which appear to be best situated to benefit from the development of automation requires considerable judgment. As pointed out, automation will be a gradual process over a period of years, and many of the companies in the field may experience a number of "ups and downs" due to other causes before automation becomes a major factor. The shares of some of these companies such as International Business Machines, General Electric, and Minneapolis-Honeywell are already selling at high levels. While all of them will be affected by the course of general business activity, some of them, such as the machine tool and machinery group, are engaged in volatile industries which tend to experience wide fluctuations from one phase of the business cycle to the other. Automation is still at such an early stage that it is difficult to forecast with any degree of accuracy those concerns which will prove to be outstanding in the field, and it cannot necessarily be assumed that only the large companies with extensive research departments will prove dominant. As a matter of fact, some of the small companies appear to be unusually interesting, but markets for the shares of such concerns are naturally limited by the small amount of stock outstanding in the hands of the public.

The field of automation is so vast and the directions which its development may take are so varied that some interesting situations may be omitted from the list below. Furthermore, managements of some concerns which have yet paid scant attention to automation may still have an opportunity to enjoy a vigorous participation in its development.

The classification of companies which will benefit from the development of automation is broad, but in the interest of simplification we are dividing them as follows:

(1) Data processing
(2) Electronic components
(3) Control instruments
(4) Machine tools and machinery
(5) General Automation

Of course, there is overlapping since these categories have been arbitrarily selected. Subject to miscellaneous influences of a near term character, all of these issues appear attractive should automation grow to the stature which can now be foreseen.

Data Processing

The stocks in this group should be among the first to benefit from the development of automation because data processing is, of necessity, the initial phase of the program. Also, data processing may be employed in numerous accounting and engineering applications. *IBM* is the outstanding company in the group and although the stock is selling at quite a high level in comparison with earnings, the long term growth prospects are today, perhaps,

Table 1.—Data Processing

Company	Current Price	1954 Range High	1954 Range Low	Per Share 1953 Earnings	Per Share 12-Month Dividend
Burroughs Corporation	28	25⅞	15¼	$1.44	$1.00 (A)
International Business Machines	370	375	271	8.33 (B)	4.00 (C)
National Cash Register	42½	103¾	57⅝	5.12 (B)	3.00 (C)
Remington Rand	47⅛	36½	14¼	2.32	1.00
Underwood Corporation	37	38⅜	27	1.13	1.00 (A)

In all tables:

A = Indicated dividend rate.
B = Adjusted for stock splits and stock dividends.
C = Stock dividend paid.
E = Bid price only.

as favorable as they have ever been. *Burroughs Corp.* and *National Cash Register* are also selling at high prices, but they should benefit along with IBM. *Remington Rand* has also been active in this field and the shares are selling at more reasonable prices in relation to reported profits than other companies in this field. Recent earnings of *Underwood* have been down sharply because of lower profits from its typewriter and office equipment lines which comprise the bulk of the company's business, but the company's venture into the punched-card field holds long-term promise.

Electronic Components

Almost all manufacturers of electronic components should benefit from this vastly wider application of electronics. These companies have been selected because it is believed that the pattern of their research is adapted to the development of products used in automation. *Audio Devices*, although speculative, has a satisfactory past record and its products could have a multitude of applications in automation. *RCA* is the outstanding company in this field but is so large that its other interests may prove to be the dominant stock market factors during the near term. *Raytheon* must be regarded as speculative in character. *Sprague Electric* has, in the past, been outstanding for research which can be turned into profits. *P. R. Mallory* is currently importantly interested in the production of TV tuners but the management has exhibited ability to adapt production of components for new developments in electronics.

Table 2.—Electronic Components

Company	Current Price	1954 Range High	1954 Range Low	Per Share 1953 Earnings	Per Share 12-Month Dividend
Audio Devices	4	3⅝	2¼ (E)	$ .18 (B)	$ .09 (C)
P. R. Mallory	50	52½	41½ (E)	3.74	2.00 (A)
Radio Corp. of America	41⅝	39¼	22½	2.27	1.20 (A)
Raytheon	21⅝	20⅜	8½	1.39 (B)	(C)
Sprague Electric	50	82	53 (E)	3.75	1.60

Control Instruments

The field of control instruments covers so wide a range that the companies in this classification differ considerably from one another in the activities in which they are engaged. One of the outstanding companies in this group is *Minneapolis-Honeywell*, and its management is exhibiting a keen awareness of the potentials of automation. *American Bosch* must be regarded as speculative in character. *American Machine & Metals* has an improving earnings outlook which adds speculative appeal to these

Table 3.—Control Instruments

Company	Current Price	1954 Range High	1954 Range Low	Per Share 1953 Earnings	Per Share 12-Month Dividend
American Bosch	18	15¼	9	$1.00 (B)	(C)
American Machine & Metals	31	30¼	17¾	4.08	$1.60
Beckman Instruments	23⅞	27½	13¾	.70	NIL
Bendix Aviation	112	105½	60	7.63 (B)	3.00 (C)
Clark Controller	19⅝	19¼	12	2.04	1.00 (A)
Consolidated Engineering	28⅛	31½	13½	.57	.40
Cutler Hammer	69½	64¾	39	5.69	2.50
Gamewell	38½	38	23	3.6[illegible]	1.40 (A)
Minneapolis-Honeywell	106	109½	67	3.31	2.40 (A)
Robertshaw-Fulton Controls	32	34⅜	17⅝	1.90	1.50
Servomechanisms	13	14⅝	5¾	.40	.40
Sperry	50	65¼	43¼	7.57	3.00
Square D	47	49¼	24¾	3.01	2.05

shares. The company is the largest producer of moderate priced instruments measuring pressure, flow and temperatures. *Beckman Instruments* and *Consolidated Engineering* manufacture highly specialized scientific equipment used in industry. *Bendix* and *Sperry* have long been active in the production of military equipment which should be applicable to industrial processes. *Clark Controller, Cutler Hammer* and *Square D* manufacture electrical control devices for machinery and other uses. This field can be expected to grow as automation progresses. *Gamewell's* Eagle Signal Corp. division is gaining importance in the manufacture of automatic controls for production machinery and conveyors. *Robertshaw-Fulton* is now engaged in the manufacture of automatic temperature and pressure controls with the primary outlet home cooking ranges. While the stock has advanced in price recently, the company's interest in general industrial controls augurs well for the long term. *Servomechanisms* is a new small company and the risk element is substantial due to dependence on Government orders and a strained current financial position, but the shares possess interesting speculative possibilities.

Machine Tools & Machinery

Although any company with alert management in the machine tool and machinery field should be in a position to participate in the growth of automation by the application of continuous process methods, we are concentrating on those which appear to be in the forefront of this development at the present time. *American Machine & Foundry* has long been a manufacturer of automatic machinery for the tobacco industry and has been active

Table 4.—Machine Tool & Machinery

Company	Current Price	1954 Range High	1954 Range Low	Per Share 1953 Earnings	Per Share 12-Month Dividend
American Machine & Foundry	29¾	28⅜	21⅜	$2.22	$1.00 (C)
Chain Belt	48¼	48	33½	4.02	2.50
Cross Company	38	41	8⅜ (E)	1.99	NIL
Food Machinery & Chemical	49¼	53¼	37½	3.67	2.00
Foote-Burt	18	39	16¾ (E)	6.47	1.85
Hewitt-Robins	34	34⅝	26¼	4.29	2.00
Joy Manufacturing	47¼	48⅝	31¾	5.89	3.12 ½
Lamson Corp.	13⅝	15⅜	8¾	1.27	.80
Link Belt	53⅞	53¼	38¼	4.42	3.00
Master Electric	26⅜	25½	18	2.02 (B)	1.60 (C)
Reliance Electric & Engineering	43	41	25⅛	4.01	2.00 (A)

in the past few years in enlarging the scope of its activities. *Chain Belt* and *Link Belt*, both sound companies, manufacture conveyors and materials handling machinery. *Cross Company* and *Foote-Burt* are both small machine tool companies which have been concentrating on the production of multi-operation equipment. *Food Machinery & Chemical* is a widely diversified company which has been growing in the chemical field and also has an important interest in the manufacture of machinery for food processing and general industry. *Hewitt-Robins* is reasonably priced and as a manufacturer of rubber conveyor belts should participate in any large scale automation program. *Joy Manufacturing* is the leading manufacturer of automatic mining machinery and related equipment and as such, is well situated to participate in further automation in this field. *Lamson Corp.* has a growing division engaged in the production of materials handling equipment. *Master Electric* and *Reliance Electric & Engineering* manufacture motors which are used in providing power to automatic machines. Reliance has been especially active in the combination of these motors with accompanying electrical controls. *Snyder Tool & Engineering* designs and builds specialized machine tools which would have an important bearing on construction of processes utilizing automation. The shares are speculative but appear to have merit.

General Automation

General Electric and *Westinghouse* are so large and cover such a wide range of activities that the shares of these companies cannot properly be classified in any of the above groups. Both stocks are selling at high levels in comparison with earnings but possess attractive long term growth prospects because of their interests in many fields in addition to automation. *Minnesota Mining & Manufacturing* is recognized for sound earning power and this company has diversified interests which reflect its aggressive research work. The stock sells at a high price-earnings ratio but is attractive for the long term.

Table 5.—Automation

Company	Current Price	1954 Range High	1954 Range Low	Per Share 1953 Earnings	Per Share 12-Month Dividend
General Electric	53¼	48½	37⅞	$1.92 (B)	$1.60 (A)
Minnesota Mining & Mfg.	90⅜	90	55¼	2.14	1.20 (A)
Westinghouse Electric	82½	80¾	50⅛	4.53	2.00

Events . . .

INSTRUMENTS and AUTOMATION

March 21-24

IRE National Convention and Radio Engineering Show will be held at the Waldorf-Astoria Hotel and the Kingsbridge Armory, N. Y. City. For information write Institute of Radio Engineers, 1 East 79 St., New York, N. Y.

March 29

Cleveland Section of American Society for Quality Control will hold their first Annual One Day Quality Control Conference at Hotel Carter, Cleveland, Ohio. For information write G. K. Montgomery, Jack and Heinz, Inc., Cleveland 1, Ohio.

April 4-6

Second Annual (Spring) Meeting of National Fluid Power Association will be held at The Broadmoor Hotel, Colorado Springs, Colo. For information write Barrett Rogers, NFPA, 1618 Orrington Ave., Evanston, Ill.

April 24-28

37th Annual Meeting of the Scientific Apparatus Makers Association will be held at The Greenbrier, White Sulphur Springs, W. Va.

April 25-26

First National Conference of Instruments and Regulators Division of A.S.M.E. will be held at University of Michigan, Ann Arbor, Mich. For information write J. A. Hrones, Massachusetts Institute of Technology, Cambridge 39, Mass.

April 27-29

Society for Experimental Stress Analysis 1955 Spring Meeting will be held at Hotel Statler, Los Angeles, Calif. For information write W. M. Murray, P. O. Box 168, Central Square Station, Cambridge 39, Mass.

May 2-5

Annual Research Equipment Exhibit and Symposium in Instrument Techniques and Applications, National Institutes of Health, Bethesda, Maryland. For information, write to the Supply Management Branch of NIH.

May 14-22

Chemical Engineering and Equipment Exhibition at Frankfort, Germany. For information write Dechema, Rheingan-Allee 25, Frankfort/M, Germany.

May 16-20

40th National Conference on Weights and Measures, sponsored by the NBS, will be held at the Shoreham Hotel, Washington, D.C. For information write W. S. Bussey, NBS, Washington 25, D. C.

May 18-20

National Telemetering Conference sponsored by the IRE, AIEE, IAS and the ISA, held at the Hotel Morrison, Chicago. For information write Raymond C. Mayer & Associates, 36 West 46th St., New York 36, N. Y.

May 23-27

Third Annual Conference on Mass Spectrometry, sponsored by the ASTM Committee E-14 will be held at the Mark Hopkins Hotel, San Francisco, Calif. For information write J. G. Hutton, General Electric Co., 1 River Rd., Schenectady, N. Y.

June 6-10

Third Human Engineering Institute will be held at Dunlap & Associates, Inc., 429 Atlantic St., Stamford, Conn. For information contact M. A. Tolcott, c/o Dunlap & Associates.

June 9-10

Conference on Carbon will be held at University of Buffalo, Buffalo, N. Y. For information write Carbon Conference, Department of Physics, University of Buffalo, Buffalo, New York.

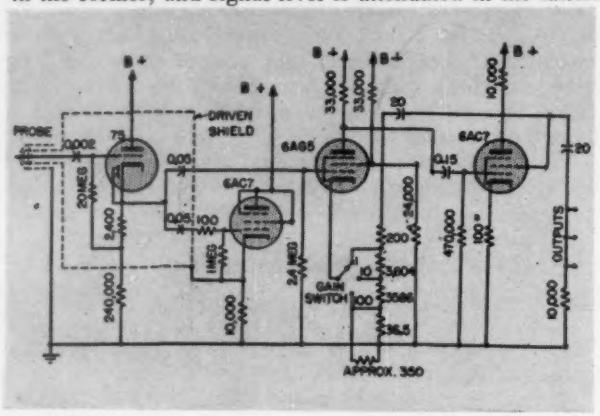
November 14-17

Second International Automation Exposition will be held at Chicago's Navy Pier. For information write The Second International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Penna.

ELECTRONIC

ISOLATION AMPLIFIER CANCELS CABLE CAPACITANCE

High input resistance plus low shunt capacitance are needed in an a-c test instrument to prevent loading the circuit under test. Yet there is little help in reducing the input capacitance of the first amplifier stage of the instrument when the shielded input cable contributes 50- to 100-uuf capacitance. Various means have been devised to overcome the cable capacitance: sometimes the signal is rectified in the signal probe and passed through the cable as dc; often, as in laboratory oscilloscopes, the signal probe contains a capacitance voltage divider, with a small input capacitor working into the larger cable capacitance. Neither of these is particularly desirable with low-level signals because d-c amplification has problems of its own in the former, and signal level is attenuated in the latter.



The circuit, called the "Phantom Repeater" by its manufacturer, overcomes cable capacitance in still another way —by driving the cable shield to "follow" the signal. With the signal lead and the shield thus remaining at the same potential, there is slight tendency for capacitive (or resistive) currents to flow between the two, and cable capacitance is essentially neutralized (reduced to 6 uuf). A second shield around the driven shield is returned to ground to minimize pickup.

Input stage Type 75 (or 6S8GT) is a cathode follower that drives both the first 6AC7 and the 6AG5. The former is a cathode follower that drives the shield; the latter is the first stage of a 2-stage amplifier that provides selectable over-all gain of 1, 10, or 100; gain is changed by varying the feedback (degenerative) from the output to the cathode of the 6AG5.

Input impedance: 300 megohms shunted by 5.7 uuf.

Gain: 1, 10, or 100

Frequency response: Flat within 2 percent, 5 cps to 150 kc.

Output: 10 v rms into 3000 ohms with distortion below 1 percent.

Output impedance: Depends on gain—300 ohms at 100 gain; 70 ohms at 10 gain; 10 ohms at unity gain.

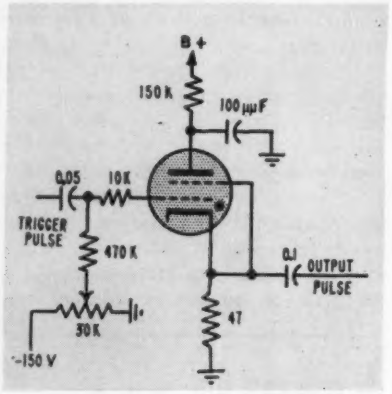
B supply: 250 v.

Noise (referred to input): 30 microvolts rms with input shorted, 70 microvolts rms with input connected across 1 megohm.

Source: Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio.

MICROSECOND-SPIKE GENERATOR

A single 2D21 thyratron forms pulses of less than 1-microsecond duration in this simple circuit. Output is 150-v pulse at low impedance (produced from pulse or sine or square-wave input). Grid of the thyratron is normally cut off by negative grid bias which is adjustable by the 30K potentiometer. When cut off, the 100-uuf capacitor in the plate circuit is charged to the supply voltage through the plate load resistor. When the thyratron is triggered by a positive signal, the capacitor discharges through the tube and cathode resistor. After a 90-microsecond deionization time, the thyratron extinguishes, the plate capacitor recharges, and the thyratron is ready to be fired again.



Repetition rate: 0 to 8000 pps.

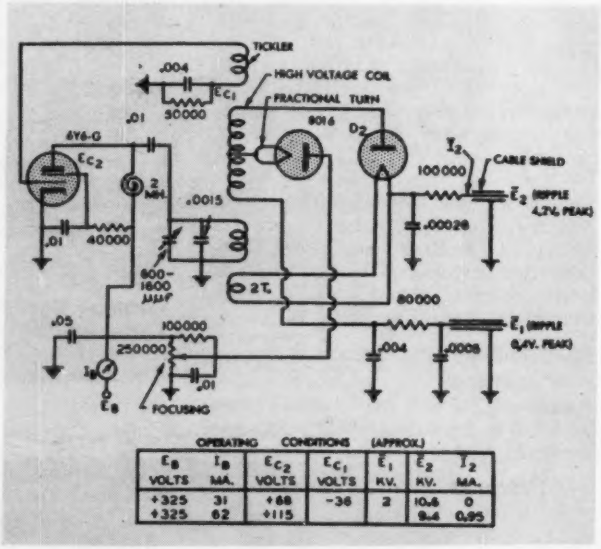
Output: pos. 150-v pulses, duration below 1 us.

B supply: 250 v.

Source: Karl Greif in *Electronics*, Sept., 1954.

RF-OPERATED HI-V SUPPLY

RF oscillator (type 6Y6-G operating at 300 kc) induces high voltage in high-voltage coil. High-voltage diodes rec-



OPERATING CONDITIONS (APPROX.)

E_b VOLTS	I_b MA.	E_{c_2} VOLTS	E_{c_1} VOLTS	E_1 KV.	E_2 KV.	I_2 MA.
+325	31	+68	-36	2	10.6	0
+325	62	+115			9.4	0.95

CIRCUITRY

The circuit is the heart of all electronics. Here are six more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

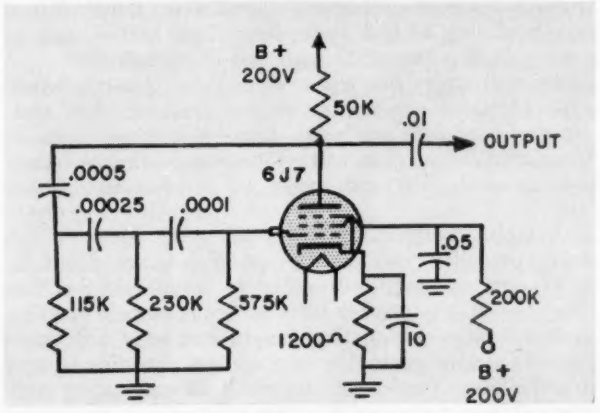
tify signals to give two outputs—one is about 10 kv, other is 2 kv. Filaments of diodes are heated by r-f induction from oscillator source. Type 8016 diode produces the 2-kv source that can be adjusted by "focusing control" (for kinescope focusing). Diode D2 (experimental diode) produces 9 to 10 kv with 325-v B supply.

Operating conditions: see table.

Source: RCA Laboratories Div.

PHASE-SHIFT OSCILLATOR

A source of pure tone often is needed. Simplicity and low distortion (1.5 percent) are the principal features of this phase-shift oscillator. Three resistance-capacitance



L-sections produce 180-degree phase shift in the feedback path at 1600 cps. Frequency may be changed to any other frequency F (within the pass band of the amplifier) by changing the phase-shift capacitors by the factor 1600/F. Output should be connected to high impedance to avoid loading.

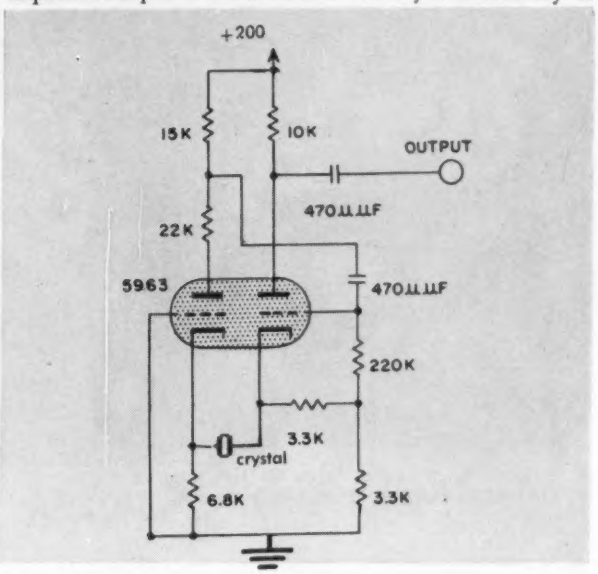
B Supply: 200 v at 3 ma.

Distortion: 1.5 percent.

Source: T. R. England in *TeleTech*, June, 1953.

CRYSTAL OSCILLATOR

Intended for a precision frequency source in the range from 50 to 250 kc, this circuit oscillates at the series-resonant point of the crystal, providing noncritical low-impedance-input connection for the crystal. Stability is



determined by crystal characteristics. Essentially a regenerative amplifier, the circuit is cathode coupled via the crystal to complete its feedback loop. Frequency is independent of external load. Circuit is available as plug-in unit from supplier.

Output signal: 40 v peak-to-peak, no-load.

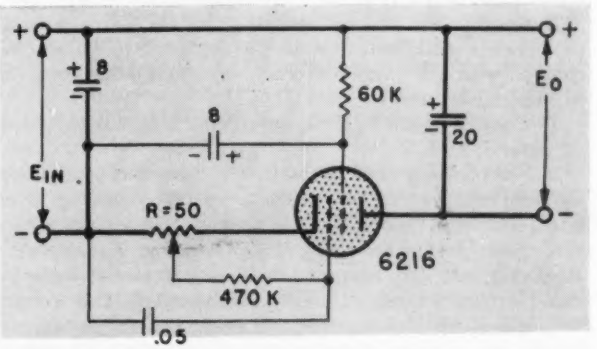
Load impedance: 100,000 to 250,000 ohms.

B supply: 200 v dc at 3.5 ma.

Source: EECO Production Co., 827 S. Vermont Ave., Los Angeles, Calif.

TUBE-FILTER CIRCUIT

A miniature pentode replaces a bulky 12-henry 100-ma. choke in this filter circuit. Input is 400 v dc, unfiltered. Ripple current develops voltage across 50-ohm potentiometer in cathode circuit. Ripple voltage across lower portion



of R is applied to grid through 0.05-microfarad capacitor. Polarity is such that this amplified signal across load impedance is in phase opposition to the ripple voltage across load. Resulting ripple across load is reduced to 0.2 v p-p (compared with 0.28 v with conventional choke) at 100 ma. DC voltage drop across tube is 55 v (compared to 30 v for choke) at 100 ma.

Input voltage: 400 v dc unfiltered.

Output voltage: 345 v dc filtered (at 100 ma).

Load current: 100 ma max.

Ripple voltage: 0.2 v peak-to-peak.

Source: CBS Hytron, Danvers, Mass.

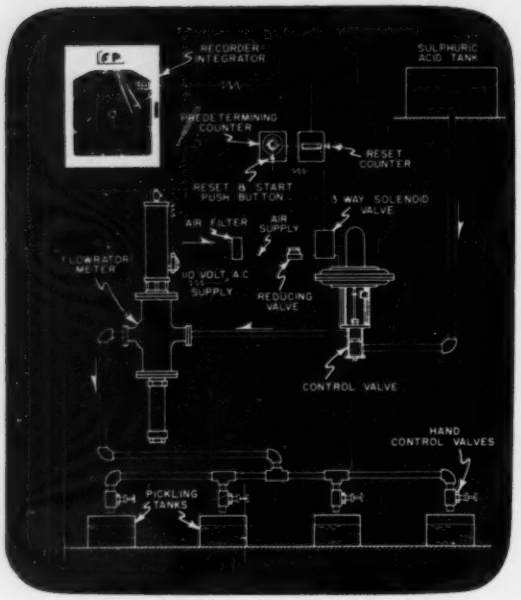


Fig. 1. Batch control system for tank make-up or spot addition of acid in batch-type pickling.

Strip Pickling Requires ACID

Continuous control of acid addition to cascade pickling line maintains both acid and iron concentrations at constant and economic levels. Instrumentation is presented for both batch and continuous proportioning-type control.

NOT many years ago 50 to 75 pounds of acid were consumed per ton of steel pickled because of the relatively low cost of sulfuric acid, its availability, and existent inefficient methods of pickling (which included guess-work systems for the control and measurement of acid additions). However, the advent of continuous hot- and cold-rolled steel strip and the tremendous consumer demand for such products led to the development of modern continuous strip-pickling equipment, which in turn caused the industry to become more cost-conscious.

One commodity on which savings could be realized was sulfuric acid. Other reasons for curbing acid consumption later arose because of the limited availability of sulfuric acid, anti-stream-pollution legislation, and the corollary problem of waste-pickle-liquor disposal. At one period the predictions of acid availability became sufficiently alarming to cause investigation of alternate methods for the removal of hot-rolled scale.

A development of this activity were the following improvements and innovations to augment pickling efficiency (which is simply effecting complete scale removal in minimum time):

1. *Control of scale formation* during hot rolling by use of water sprays.

2. *Pre-pickling scale removal* by (a) scale breaking by subjecting strip to alternate reverse bending over small-diameter rolls, (b) scale breaking by a light reduction pass, (c) scale removal by blasting surface with steel shot, and (d) radiant pre-heating to loosen scale by rapid surface expansion and to accelerate pickling action.

3. *Chemical pickling aids* and better control equipment by (a) use of wetting agents to pre-wet strip, (b) use of inhibitors to prevent over-pickling, (c) improved construction features to provide better heat insulation of pickle tanks, (d) motorized valves and improved accessory heating equipment to provide better heat control, and (e) automatic acid-measuring equipment to provide better control of pickling-solution concentrations.

Modern equipment which embodies the better features of these developments is currently employed on the continuous strip pickler located at the Aliquippa Works of the Jones & Laughlin Steel Corporation.

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March 25, 1954.

Pickling Tanks

There are four pickling tanks (Fig. 1) on the same level, constructed of 3/8-inch steel, lined with Triflex rubber that is insulated with an 8-inch double-course brick lining, bonded together with acid-proof cement. Each tank is 80-feet long, 54-inches wide, and 50-inches deep. The maximum volume of each tank, determined by location of overflow drains, is 8400 gallons.

A large rubber hold-down or dunking roll is located at the ends of each pickle tank. These rolls are operated by air cylinders and are designed with a tie between the end bearings to keep them parallel with the carry-over rolls located between each tank. The rolls may be raised or lowered as desired, and hold the strip in the acid. The effective pickling length of the tank is increased by lowering the rolls, and decreased by raising the rolls.

The pickling solution is heated by steam emitted through jets contained in and spaced along the horizontal length of each of four steam lines. Two heaters, one on each side, are located in each end of each tank.

An acid-supply line and a water-supply line for batch-type additions are located at each end of each tank. Number four (the exit pickle tank) is equipped with an extra acid line and an extra water-supply line to handle proportioned acid and water for continuous cascade pickling.

Adjacent pickling tanks are connected by an 8-inch valve-controlled interconnect pipe. Valves are closed for batch-type pickling, and opened to permit solution flow from one tank to another for continuous cascade pickling. A combination of solution weight and level differences causes the solution to flow in a counter direction to strip travel—from No. 4 tank (to which all continuous additions of acid, water and inhibitor are made) back through the other tanks to the point of discharge. Discharge is through an overflow drain, located at the entry end of No. 1 tank.

All drains are constructed of rubber-lined carbon steel. The tanks and piping used to store and transport concentrated acid (66° Baumé) are constructed of unlined carbon steel except for (1) lubricated stop-cock-type valves of cast iron, (2) acid lines leading into pickling tanks of lead, and (3) several wetted metallic parts of

CONTROL

W. H. STUCK

Jones & Laughlin Steel Corp.

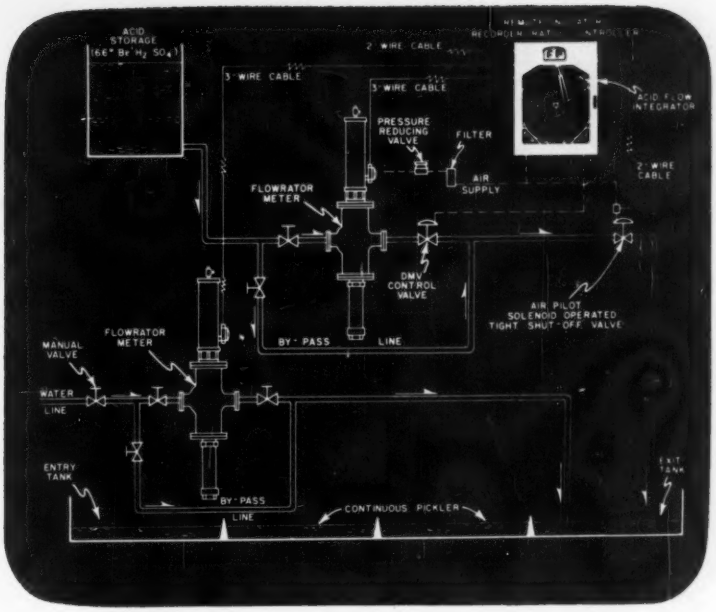


Fig. 2. Control system for continuous proportioning of acid and water in cascade pickling.

the acid metering and control system. Although carbon steel is used for the meter fittings, a corrosion resistant alloy, Hastelloy "C," is used for the extension well, metering tube, and metering float. This is necessary for accuracy in metering.

These features are incorporated in the instrumentation of both the batch-control system and the continuous proportioning system of the installation under consideration. Both systems are supplied with acid by gravity feed from either of two 20,000-gallon storage tanks located nearby.

Acid Measuring Equipment

Acid may be added in three ways. The first, with which all are familiar, is the method of opening a valve and estimating the amount of acid added. This method would be used only in emergencies or to purge lines.

The second is the batch-control system, (Fig. 1) which can be used for new tank make-up or spot additions in batch-type pickling. An area-type "Flowrator" meter having both visual indication and electrical transmission is installed in the main acid flow line between the storage tank and the various pickling tanks. The rate of flow measured is transmitted electrically to a remote recording and totalizing instrument. An on-and-off air-operated valve is installed in the same acid line and is actuated through a 3-way air solenoid.

To provide for automatic transfer of a desired quantity of acid, the sequence of the operation is as follows: the operator opens the hand valve to the designated pickling tank and then sets the dial of the predetermining counter for the quantity of acid to be transferred. The system is then energized by pushing the momentary contact button on the predetermining counter, which holds the clutch coil in an open position and energizes the solenoid which admits air to the diaphragm, opening the main control valve. The flow of acid continues until the impulses of the integrator of the flowmeter equal in number the pre-setting of the counter, at which time the clutch coil is tripped and the solenoid is de-energized; this immediately exhausts air from the valve diaphragm and closes it. Each of the flowmetering impulses is accumulated on a counter so that the total amount of acid used during the turn is available.

The third method used is the continuous proportioning system which controls the continuous addition of acid and water (Fig. 2). This method is used with cascade pickling. Area-type "Flowrator" flowmeters having direct visual indication and electrical transmitters are installed in both acid and water supply lines. The flow of these meters is transmitted electrically to a remote recording and ratio-controlling instrument, which proportions the acid to the water. This recording-controlling instrument is equipped with an integrator for totalizing the acid consumed. Also provided is an electric limit switch which is actuated when the water flow falls below a pre-set minimum. Installed in the acid flow line is a diaphragm-motor valve to throttle the flow in accordance with the air output from the controller. A second valve is used to provide a tight shut-off and is connected by means of a three-way air solenoid to the limit switch on the water function of the ratio controller.

Before operating this equipment it is necessary to know the correct amount of acid and water to be added and the number of tons being pickled per hour. The acid and water requirements are determined by referring the tons per hour being pickled to a chart which is calculated on the basis of using 35 lb. of 66° Baumé sulfuric acid for each ton of steel pickled. The chart shows tonnages from 40 tons per hour up, and the amounts of acid and water required for each in order to obtain 15, 18, 20, 25, or 30 percent acid solutions. Percentages are calculated on a weight basis.

The operator sets the ratio dial of the proportioning instrument for the desired percentage of acid and then opens the manual valve on the water line until the desired water flow is attained. At this point the ratio controller takes over to proportion the correct amount of acid. The amounts of water and acid used are recorded on a calibrated 24-hour chart, and the amount of acid used is accumulated on two accumulating totalizers, one of which may be reset at the beginning of each turn.

A logical question that might be asked at this point is, "why have three methods for making acid additions incorporated in one pickle line"? The first method is for emergencies and purging; the reasons for having both the batch and continuous addition methods are found in the following operating experiences.

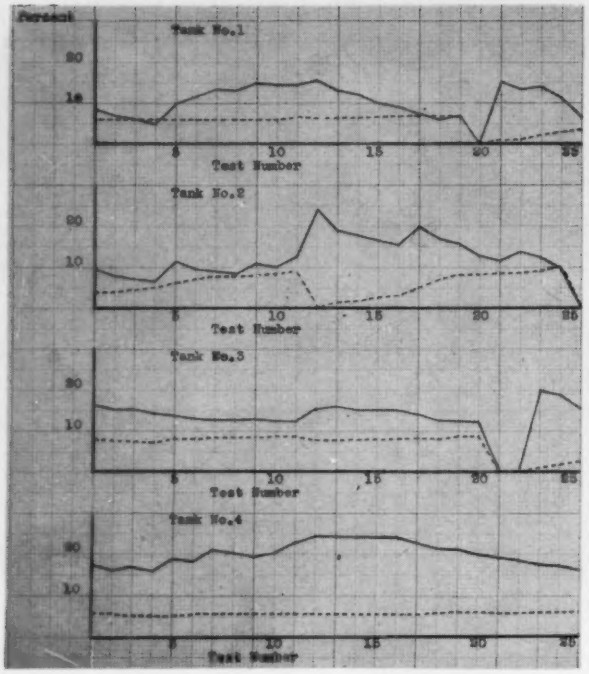


Fig. 3. Percent acid and iron in the four pickling tanks with batch-type acid addition.

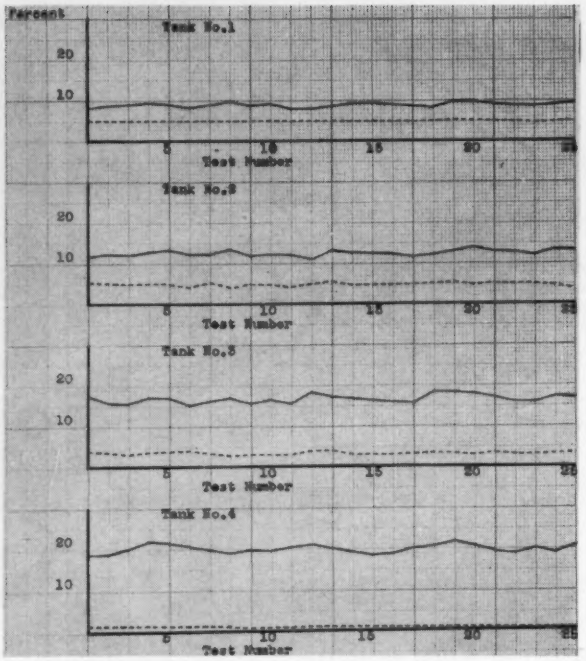


Fig. 4. Percent acid and iron in tanks with continuous proportioning control of acid addition.

Experiences With Equipment

For the first seven months this line was in operation, the batch method of making additions was used. Since that time, except on a few occasions when interconnect piping failures isolated one or more pickling tanks, the continuous addition method has been used almost exclusively.

With batch-type control, each tank was made up with 8400 gallons of solution that was approximately 20-percent acid. Periodically, additional acid was added to maintain this percentage until the iron content of the solution reached 5 to 6 percent by weight. (All solution concentrations are expressed in terms of weight percent of pure acid or pure iron.) At this point acid additions were discontinued and the tank pickle solution permitted to work down in acid and up in iron concentration until the acid reached 9 to 10 percent, and the iron 7 to 9 percent, at which time the tank was dumped and a fresh solution made up.

With batch pickling, iron sulphate cyrstals would frequently build up on the bottoms of tanks in large quantities. This would necessitate removing tank covers while the deposit was being washed out. A few times the deposit became encrusted with crystals of the heptahydrate form, which required prying and digging to loosen. On one occasion a drain valve assembly had to be taken apart to remove the crystals. In order to do a satisfactory job of pickling while replenishing spent solutions, line speeds were usually reduced with a resultant loss of production.

Proportioned continuous-acid-addition-type solution control, as practiced on this line, has proven satisfactory both from the standpoint of acid measurement and control. The outstanding feature of cascade control is the high degree of uniformity that can be maintained from day to day and month to month. This is true not only from the standpoint of solution concentrations, but also includes over-all pickling performance. Figs. 3 and 4 compare batch and continuous acid-addition solution-concentration, and illustrate the advantages of continuous acid addition.

Another important advantage of cascade pickling is the flexibility for pickling various grades of steel.

Considering all these advantages of continuous cascade pickling might give the impression that the batch-method addition equipment is superfluous. However, this is not true because it is important auxiliary equipment which should be included in installations of this type to provide measured acid for (1) making up new solutions of any desired concentration to replenish a tank that has been dumped, to permit repairs, or in event of a strip break, (2) making supplementary acid additions to quickly increase acid concentrations to compensate for an increased production rate, or to accommodate a steel which is especially difficult to pickle, and (3) emergency stand-by.

Summary

The following is a brief summary of the more important features and experiences associated with the instruments for measurement and control of acid additions in continuous strip pickling:

1. The instruments permit operating with either batch or continuous proportioning-type acid additions
2. Each type performs important functions necessary to good pickling practice. Both types not only measure desired amounts of acid but also record these amounts to provide essential acid inventory and consumption data
3. Reduced production, attributed to iron sulphate buildup in solution, was experienced when operating with batch-type pickling
4. Cascade pickling has been successful. The continuous addition of acid holds solutions within desired concentration limits from day to day. Iron sulphate does not build up to an objectionable point. Greater flexibility is provided for pickling different grades of steel, and more uniformity is possible when pickling the same grade of steel. Continuous cascade pickling has permitted faster average pickling speeds.

Reference

W. H. Stuck and J. H. Abrams, "Continuous Cascade Pickling," *Iron and Steel Engineer*, Feb., 1951.

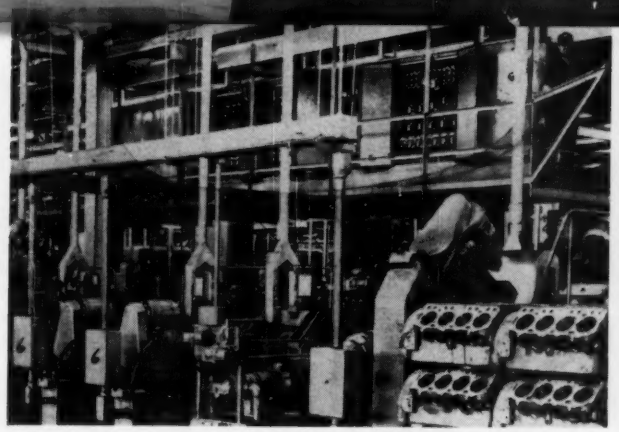


Fig. 1. The maintenance man on this control panel platform stands near a fluorescent-lighted wiring diagram panel. He can readily see the machine, the upper terminal box, the wireway runs, and the lower oil-tight terminal boxes.

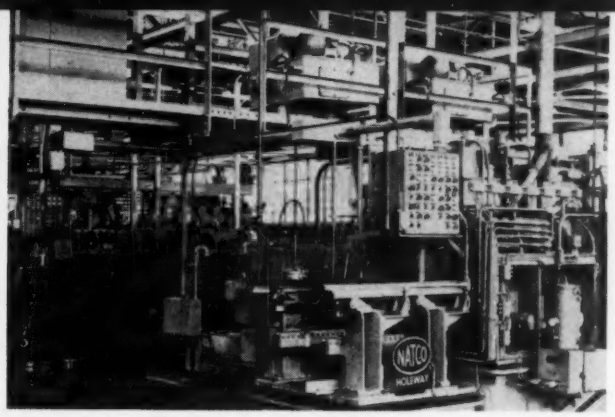


Fig. 2. This platform-mounted control panel is part of Buick's second process line for V-8 engine blocks, now under construction. Hydraulic pump units are mounted on the platform.

Automatic machine-tools require

CONTROL-PANEL PROTECTION

The machine-tool control panel is the heart and nerve center of the automatic machine. Important panel factors include mounting location, protection, cost, and accessibility. A list of recommendations provided by the Buick Motor Company is presented.

HAROLD HARDENBROOK
Buick Motor Co.

MACHINE control panel is the heart and nerve center of the machine. Care must be given to the location of this control panel so that it will be protected from dirt, chips, coolants, and oil thrown off by machines. It must also be protected from factory trucks and misplaced parts.

In general, we at Buick found that overhead platforms (Fig. 1) have proved to be best from the standpoint of space availability, possible damage, and physical relation to the machine.

Cost

Many people have asked about the cost of overhead platform mounting versus floor mounting. This is a difficult question to answer because (1) a building may cost $10.00 per sq. ft. to build, but due to machinery arrangement, this manufacturing space may be worth $100.00 or more per sq. ft. per month; (2) available space for mounting the panel may be a considerable distance from the machine, thus requiring longer conduit and wire ways, hundreds of feet of copper conductors and loss of all the advantages the platform mounting has to offer; (3) most platforms cost less than one percent of the machine cost.

Other factors that should be considered in connection with platform-mounted panels include: (1) They should be front-connected to eliminate doors on the back: this reduces the width of the platform; (2) the height should not exceed 72 inches; (3) there should be ample room for wiring around the control inside the panel; (4) panels should be built in 8-ft sections that can be assembled as a single unit.

Presented at the 18th Annual Machine Tool Electrification Forum, sponsored by the Westinghouse Electric Corporation, Buffalo, N. Y., April 6 and 7, 1954.

Recommendations

To eliminate down time and lost production, and to assist our maintenance men in locating and correcting electrical failures, Buick Motor Division recommends the following considerations when control panels are being engineered and built for multistation process machines:

(A) All possible control equipment for each head be mounted together as for a single unit panel.

(B) When sectionalizing disconnect switches are used, they should be located behind the panel door for the control affected.

(C) On multidoor panels, no control apparatus should be mounted behind door frames or gutters where removal or service is difficult.

(D) Interlocks with doors and disconnect switches should be arranged so that switch must be open to open door, but that the open door can be latched closed when disconnect switch is closed.

(E) Mount terminal strips in vertical plane at side of its respective panel section (instead of mounting horizontally below the wearing parts) to avoid dirt dropping from moving and wearing parts.

(F) Provide a ground detector relay with the coil connected in series with the grounded side of the control transformer and the N.C. contacts of the relay, opening the ungrounded side of the control circuit should a ground occur.

(G) Nothing smaller than size "0" relays be used.

(H) Lighting be installed inside of panel enclosure for night maintenance work.

(I) Provide over-current protection for conductors to solenoids (such as brakes, valves, etc.).

(J) All control equipment should be spaced so that there will be room and clearance for mounting the next-size-larger control device.

Weathering tests require

Controlled Ozonized Atmospheres

Ozone, present in concentration of only 4 to 6 parts per hundred million in the air at the earth's surface, is found to be prime malefactor in weathering of rubber. Techniques for generation of controlled concentrations of ozone open new fields for investigation of age-old problem of weathering.

DALE J. MILNES
Mast Development Co., Inc.

MOST ORGANIC substances upon exposure to weather suffer depreciating alterations in their physical characteristics ranging from simple fading, cracking, and crazing to complete and permanent loss of tensile strength.

Air at the earth's surface is known to consist of a mixture of the following constituents: Major: nitrogen and oxygen; minor: carbon dioxide, argon, helium, neon, krypton, and xenon; Trace: ozone, nitrogen oxides, ammonia, sulphur dioxide, sulphuric acid, hydrogen sulphide, carbon monoxide, hydrocarbons, hydrogen, mineral salts, hydrogen peroxide, and organic peroxides. Of the many constituents, only oxygen, ozone, and nitrogen oxides are capable of reacting with rubber; of the latter three, considerable experimentation has demonstrated that only oxygen and ozone produce any perceptible effect in the concentrations which are present.

Ozone

Ozone, discovered by Schonbein in 1840, is an allotropic form of oxygen containing three atoms in the molecule (0_3). It is a very unstable and powerful oxidizing agent, considerably more active than oxygen (0_2). It was early discovered that its presence could be induced by passing an electric arc through air, and its presence could be detected by its peculiar and immediate effect upon potassium iodide, liberating free iodine. Not until 1940 were the first dependable measurements of ozone concentration in the atmosphere made, by Edgar and Paneth[1]. The normal concentration of ozone in the atmosphere near the surface of the earth is 4 to 6 pphm. (parts per hundred million).

Preliminary investigations into the relative roles of temperature, humidity, light, and air as factors in the crazing of rubber (Fig. 1) revealed a correlation between light and this special effect[3-4]. The ultraviolet component of light was found to be the prime factor. Later studies[2-5-6] proved that a product of ultraviolet radiation in air (ozone) is the outstanding causative factor, and that the subsidiary factors (temperature, humidity, and light) influenced the rate of attack.

The theory is now accepted that the significant cause of atmosphere ozone is a photochemical action of ultraviolet light upon oxygen in the *stratosphere*. The ozone is carried to the surface of the earth by convection currents; no ozone is formed by ultraviolet light at the surface of the earth because light of the necessary wavelengths is completely absorbed before reaching the lower atmosphere. Light of the longer wavelengths, which exists at the earths surface, breaks down the ozone and returns it to the oxygen state. The totality may be considered a continuous cycle; the total ozone concentration in the atmosphere is essentially constant (4 to 6 pphm, but varying with topography; latitude, season, and industrial activity). Its average concentration is highest in the summer and lowest in the winter, the concentration tending to be inversely proportional to distance from the equator.

Having established the fact that ozone is the major cause in the crazing of rubber, the next step was to devise a laboratory system for the production and control of ozone—that is, an ozone generator and concentration control.

Ozone Generation and Control

The basic chemical principle for a system of ozone control was discovered accidentally by Faulk and Bawden[7] in 1926. In preparing for the titration of iodine in what was then the conventional manner, it was discovered that iodine may be titrated by a thiosulphate solution in an

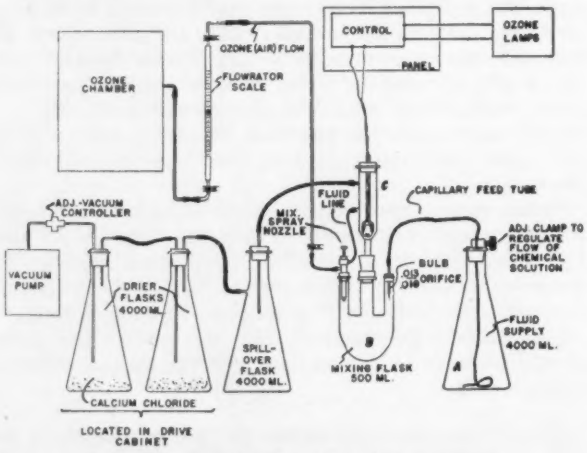


Fig. 1. Ozone production and control apparatus.

apparatus that consists of a pair of electrodes across which there is a potential difference of 10 to 15 millivolts. In the presence of free iodine, it was observed, current will flow, diminishing in value as the concentration of iodine diminishes, the latter due to the back electromotive force of polarization, a consequence of complex ionization effects at both anode and cathode. This principle is used in the control of an Ozone Test Chamber as developed by Mast Development Company, Inc. (Fig. 2). Essentially, the device consists of a chamber in which ozonizing is accomplished, an apparatus for the production and control of ozone, a mechanical system for flexing and stretching samples, and ductwork, temperature and vacuum controls.

Fig. 1 shows the ozone production and control apparatus. It uses a special application of the principle of the titration of iodine liberated from a potassium iodide solution by the continuous flow of ozonized air. Ultraviolet lamps generate the ozone. Variations in the conductivity of the solution control the operating cycle of the ultraviolet lamps; this conductivity is determined in turn by the rate of injection and the normality of a solution of potassium thiosulphate. Flask A contains a solution of potassium iodide and sodium thiosulphate, the latter of a selected normality which is calculated to produce the desired ozone concentration.

Both ozone and the titrating solution are drawn by a vacuum pump into the mixing flask B and thence to electrode flask C. In flask C there are the two platinum electrodes which are connected to a relay which determines the operation of the battery of ultraviolet lamps. So long as the current flow across the electrodes is less than 5 microamps at 15 millivolts the ultraviolet lamps continue to generate ozone. As the iodine content increases, and the current increases, the output of ozone is diminished and ultimately a state of equilibrium is attained, the value of which is a function of the normality and rate of injection of the iodine neutralizing sodium thiosulphate. In practice, the control maintains ozone concentrations at desired values within a probable error of 2 percent at 2000 pphm. The attainable range of ozone concentration can vary from as low as 1 part of ozone per hundred million parts of air to 10,000 parts of ozone per hundred million parts of air.

To protect the vacuum pump the neutralized solution is withdrawn through calcium-chloride dessicant flasks which remove the liquid portion, the air is then exhausted to atmosphere.

Fig. 2 shows the ozone chamber within which is the "Dynamat," a two-tier sample-holding and flexing apparatus. Experimentation has established that ozone reacts with both synthetic and natural rubbers at rates which are a function of elongation (Ford and Cooper reported that cracking was never observed unless the rubber was under stress). The device provides for controlled stretching and flexing of rubber samples. A total of eight samples can be mounted in each tier. Samples in the lower tier are mounted and maintained at a static stretch during the experimental cycle, whereas samples in the upper tier are subjected to dynamic exercising during the same cycle. Both the extent (throw) and frequency (rate) of flexing is variable and controlled.

Applications for an ozone chamber, especially in the rubber, textile, petroleum, and other industries which employ organic base substances, are numerous.

Under the heading of protection of products from ozonizing are current experimentations into the protections offered by various waxes and varnishes in the preparation of rubber products, and the resultant variations in effects afforded as a consequence of the selection of different mineral loadings, softeners, petrolatums, etc.

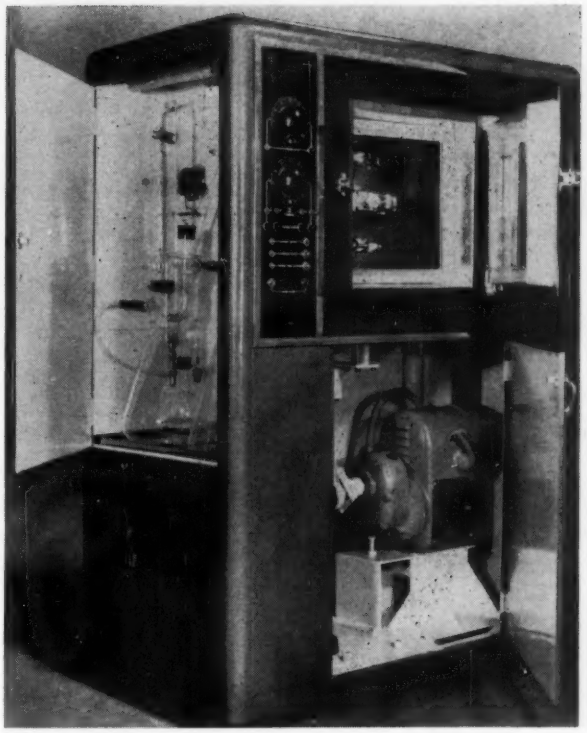


Fig. 2. Ozone chamber.

A new respect has been accorded the ever-present and pernicious allotrope ozone, the totality of which in the atmosphere would only produce a single layer 1 to 4 millimeters thick at the earths surface. But the time may not be too far distant when tires, wire insulations, cording, and other rubber products, as well as paints, fabrics, and yet other organic base products will be completely immunized to the destructive attacks of ozone in the atmosphere. American industry is leading the way.

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Acknowledgments

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How accurate are your

Temperature Reference Baths?

Accuracy of your temperature reference water baths can be affected by the water composition and the ambient atmospheric pressure. The magnitude of the effect is presented via tables and charts.

A. B. KAUFMAN and **P. R. MITCHELL**

Group Engineer* Research Engineer*

THERMOCOUPLE CIRCUITS often employ a 32-deg.-F ice bath as a cold-junction reference for temperature measurements. In this, and in the use of boiling water as a calibration point, the amount of dissolved impurities must not be allowed to exceed tolerable levels. Additionally, the ambient atmospheric pressure affects the point at which boiling occurs, as does the amount of dissolved gas in the 32-degree ice-bath reference.[1]

Ice-Bath Reference

The lowering of freezing (and melting) point due to dissolved air is ordinarily negligible—about 0.0023 degree Centigrade maximum between 0 and 80,000 feet.[2] In contrast, the lowering of freezing point due to dissolved impurities is considerable when maximum quantities are considered, being limited only by the nature and amount of impurity.

Table 1 lists the effect on the freezing point due to typical varieties of hard[3] and soft water, distilled water, and water which has been contaminated by impurities commonly encountered near electronic and laboratory equipment. The table has proved useful in the control of water supply and ice supply by separating out any inconsequential considerations and establishing tolerable amounts of other impurity in relation to calibration accuracy. It should be noted that "soft" water may contain huge amounts of impurity which, although not of the type to render the water "hard," may appreciably lower the freezing point. In any event, calibration accuracy depends on knowledge of the composition of the water and ice being used, and on the degree of cleanliness used in preparation of the ice bath.

As the effect of dissolved impurity is linear at lower concentrations, no curves are supplied to accompany Table 1.

Boiling-Water Reference

As the boiling point of water (free of excessive impurities) depends on ambient atmospheric pressure, it is not possible to use the boiling-water bath as an invariant calibrating point such as provided by the water-ice bath. However, it is possible to ascertain the actual

*Company name withheld by request.

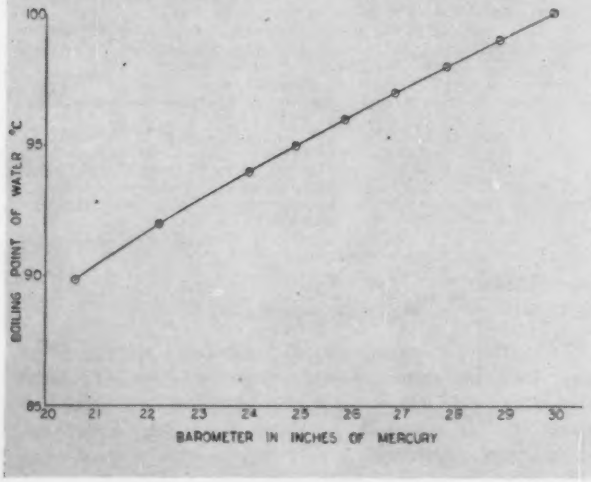

Fig. 1. Boiling point of water vs. barometric pressure.

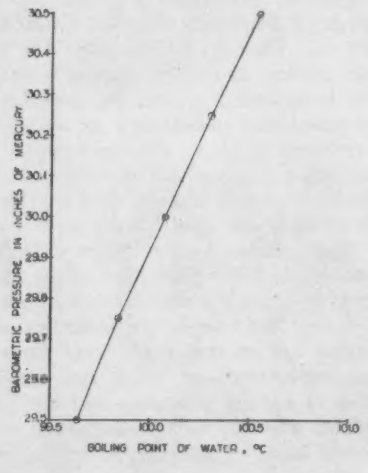

Fig. 2. Boiling point of water at barometric pressures between 29.5 and 30.5 in. Hg. (Sea level is 29.92 in. Hg.)

Table 1.—Effect of Water Composition on the Freezing and Boiling Points of Water

Water Type	*Water Composition*	*Freezing Point (deg. C)*	*Boiling Point (deg. C at 760 mm)*
Distilled	Air free	0.000	100.000
Distilled	Air saturated	–0.0023	
Los Angeles Metropolitan Water District (Recognized as extremely hard water)	$CaCO_3$—109 ppm Sulfates—274 ppm Chlorides—80 ppm Sodium—172 ppm Silica—10 ppm Calcium—32 ppm	–0.01 average	100.004
Sea Water		–2.0	
Salt Water	2% Sodium Chloride	–0.664	100.24
Alcohol-Water	1.25% Alcohol	–0.5	100.02
Soft Water	Less than 68 ppm of soap precipitating impurity. Unlimited amounts of non-precipitating impurity.	Limited only by nature and amount of impurity.	Limited only by nature and amount of impurity.

boiling point at any time to a high degree of accuracy if the barometric pressure and corresponding barometric temperature correction are known.

Fig. 1 shows the boiling point of water throughout a wide range of pressures,[4] with the range between 29.5 and 30.5 inches of mercury expanded in Fig. 2 for making accurate barometric corrections. (Barometric pressure at sea level is 29.92 in. Hg.)

As the barometric pressure decreases with altitude, the obtainable boiling point also decreases with altitude due to lowered pressure, as shown in Fig. 3.[5]

The elevation of boiling point due to dissolved impurities is considerable when maximum quantities are considered, being limited only by the nature and amount of impurity. The right hand column of Table 1 lists the effect of impurities on the boiling point.

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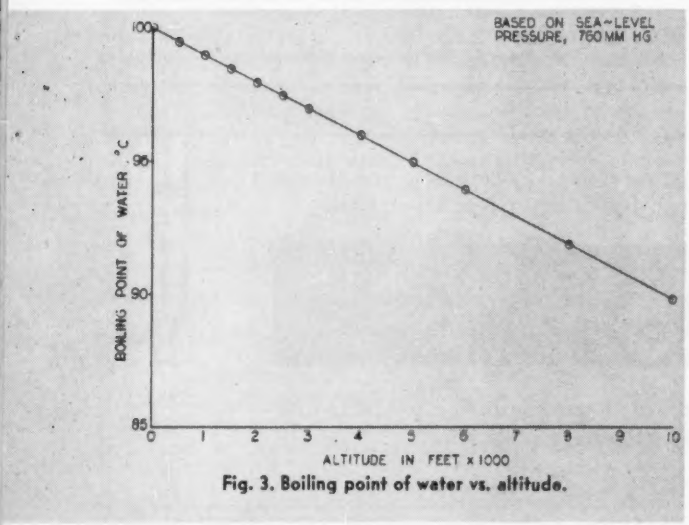
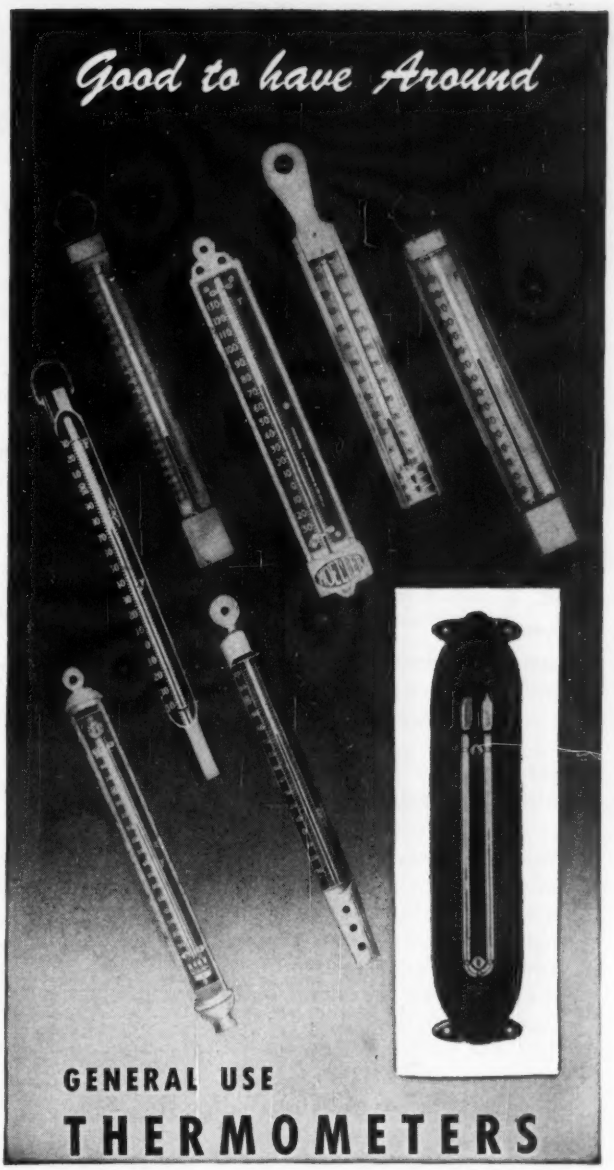


Fig. 3. Boiling point of water vs. altitude.



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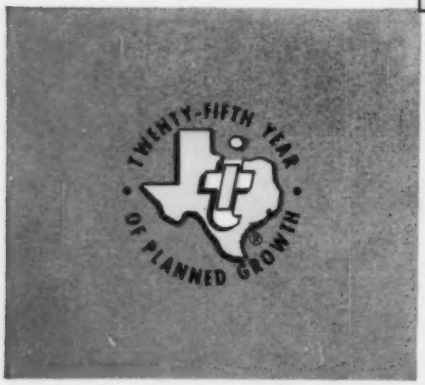
600C	—	30.0	3	1	$1\cdot10^{-6}$@−1V	100	25	100	$0.4\cdot10^{-4}$	40	15	2.5
601C	—	50.0	3	1	$1\cdot10^{-8}$@−1V	100	25	150	$0.5\cdot10^{-4}$	20	10	2.5
604C	4.7	5.5	60	1	$1\cdot10^{-7}$	150	100	150	$0.5\cdot10^{-4}$	40	40	20
606C	6.8	7.5	35	1	$1\cdot10^{-7}$	150	90	150	$0.5\cdot10^{-4}$	40	35	16
608C	10.0	11.0	25	1	$1\cdot10^{-7}$	125	75	150	$0.5\cdot10^{-4}$	20	25	12
610C	15.0	17.0	12	1	$1\cdot10^{-7}$	125	60	150	$0.5\cdot10^{-4}$	20	20	7
612C	22.0	25.0	7	1	$1\cdot10^{-7}$	125	50	150	$0.5\cdot10^{-4}$	20	20	5 *
614C	33.0	37.0	5	1	$1\cdot10^{-7}$	125	35	150	$0.5\cdot10^{-4}$	20	15	3.5
616C	47.0	52.0	3	1	$2\cdot10^{-7}$	100	30	125	$0.4\cdot10^{-4}$	20	15	2.5
618C	68.0	75.0	1.5	1	$2\cdot10^{-7}$	100	25	125	$0.4\cdot10^{-4}$	20	10	2.0
620C	100.0	110.0	0.9	1	$2\cdot10^{-7}$	100	20	125	$0.4\cdot10^{-4}$	20	8	1.4
622C	150.0	170.0	6.5	4	$2\cdot10^{-7}$	90	15	100	$0.3\cdot10^{-4}$	30	5	1.2
624C	220.0	250.0	3	4	$0.4\cdot10^{-6}$	80	10	71	$0.2\cdot10^{-4}$	40	5	1.0
626C	330.0	370.0	2	4	$1\cdot10^{-6}$	75	7	71	$0.2\cdot10^{-4}$	30	4	0.9
628C	470.0	520.0	1	4	$1\cdot10^{-6}$	70	5	71	$0.2\cdot10^{-4}$	20	3	0.7

* At maximum working voltage.

† On types 604C, 606C, and 608C reverse voltage was reduced below breakdown voltage.



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Measurement of Liquid Flow by

Positive-displacement Meters

Proper selection and application of positive-displacement meters for liquid service requires consideration of each element in the system, and of the effects of temperature and viscosity. A complete trouble-shooting guide is presented, as are typical test arrangements, calibration technique, quantity control equipment, and characteristic curves.

PAUL A. MANKIN*
Rockwell Mfg. Company

POSITIVE-DISPLACEMENT METER consists of a measuring chamber and a sealing section between inlet and outlet connections. Six common, different types are shown in Fig. 1. These meters are operated by fluid pressure and the discharge is essentially the product of piston or vane displacement by the cross-sectional area of the measuring chamber. The piston or vane is designed to cover the fixed path of constant cross-sectional area; on each revolution of the meter the constant cross-sectional area (measuring chamber) is returned upstream for the next displacement. The volume of liquid passing through the meter is measured by counting the revolutions of the meter. The following factors must be considered in the design of a positive-displacement meter: (1) The type of liquids the meter is to measure. (2) Are the liquids lubricating or non-lubricating? (3) The percentage of contaminants in suspension and particle size. (4) Degree of accuracy (usually plus or minus 0.2 percent). (5) Maximum rate of flow. (6) Minimum rate of flow (usually 20 percent of maximum—established by Sealer of Weights and Measures). (7) Practical allowable pressure drop.

No positive-displacement piston meter is entirely friction free, and a certain amount of work is required to operate the meter mechanism. This work creates a pressure drop across the meter which can lead to leakage past the vanes or pistons. It is important to keep mechanical friction at an absolute minimum via close manufacturing tolerances.

The "Rotocycle" meter (top left in Fig. 1) is constructed in various sizes from 20 to 800 gallons per minute maximum capacity, and with working pressures from 125 to 1500 psi.

*Presented by John Clarke, Rockwell Mfg. Co.

April Meeting: Thursday, the 21st, Rio Hondo Country Club, Downey, Calif.

Feature: Blair Willard, The Texas Company, will present a paper "Measurement and Control In A Gasoline Plant."

Trouble Shooting

In order to determine what causes inaccuracy in any system, it is the best policy to eliminate the possible

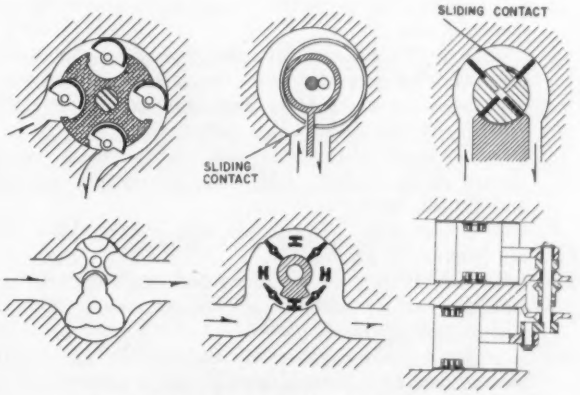


Fig. 1. Types of positive-displacement meters.

causes one by one. The first step is to discuss the conditions with the system operator. The information obtained from the operator may shorten the process of pin-pointing the trouble.

When a meter is not measuring accurately, the natural tendency is to place the blame on the meter—but in the majority of installations, particularly new installations, the cause of the trouble is in the system.

A list of the most common complaints, and the possible causes of each, are as follows:

1. *Under-Registration*

A. On old piston-meters
(1) Leakage around worn pistons
(2) Leakage around worn valve
(3) Longer piston strokes due to worn adjustment
(4) Worn bearings or mechanical interference imposes drag on meter (causing leakage).
(5) Worn register may not indicate total thruput.

B. On new piston-meters
(1) Sticky valve can cause drag on the meter (and leakage around valve and pistons).
(2) Sticky pistons would have same results.
(3) If out of adjustment the piston strokes are longer, therefore more product is going through than is being registered.
(4) A faulty register can impose load on meter (causing leakage past pistons and valve).
(5) A distorted housing can cause mechanical interference (and leakage).
(6) The meter by-pass can leak.

C. On old rotary-type meters
(1) A worn adjustment can load meter, causing leakage or improperly advancing register.
(2) A worn register will have same effect.
(3) Worn internal parts can impose load on the meter (and leakage).

D. On new rotary-type meters
(1) The adjustment mechanism may not advance register properly.
(2) The register can malfunction and not register thruput of meter.
(3) The malfunctioning of other equipment powered by meter can impose load on meter.
(4) A distorted housing can cause mechanical interference.
(5) The meter by-pass can leak.
(6) Dirt from piping or product can cause internal friction (and leakage).

2. *Over-Registration*

(A.) All types of new and old meters.
(1) The air vent in the air eliminator can stick, permitting the meter to measure air.
(2) Plugged air vent line could allow the meter to measure air.
(3) A restriction in the inlet piping to the meter can vaporize some liquids (the meter would measure these vapors). It is the best policy to push volatile liquids rather than pull them.
(4) The suction line can leak at pipe joint, valve stems, pump stuffing box, etc., permitting an air and liquid emulsion.
(5) On systems without air eliminators, look for air pockets in piping.
(6) The mixing of some liquids can result in an emulsion of air and liquid. The viscosity may not permit fast separation.
(7) An erratic register or adjustment on rotary meters can be over-registering (only rarely is this the cause of over-registration).

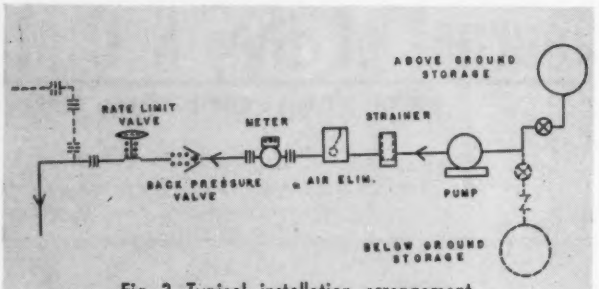


Fig. 2. Typical installation arrangement.

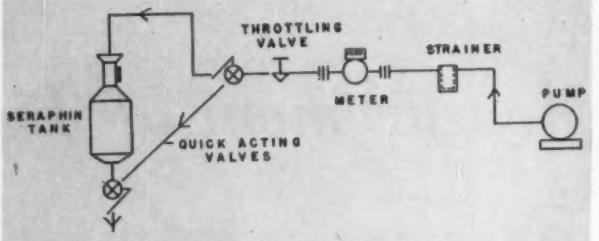


Fig. 3. Typical test arrangement.

3. *Reduced Rate of Flow*

A. All types of new and old meters
(1) The pump by-pass can leak or be stuck in the open position.
(2) The air vent valve on the air eliminator can stick open or not seat properly.
(3) The lines could be restricted by partially open valves or by build-up of product and sediment in restricted sections.
(4) Badly worn internal parts of the meter can increase the mechanical friction of the meter and reduce the flow through the meter.
(5) A worn pump can cause reduced flow.
(6) The strainer can be partially plugged.

4. *Complete Stoppage of Meter*

A. On all types of new and old meters
(1) Jammed meter.
(2) Jammed pump.
(3) Lines or strainer could be plugged solidly with sediment.

5. *Meter Gasket Leakage*

A. On all types of new and old meters
(1) The line pressure could be excessive due to liquid expansion.
(2) Line shock.
(3) Bolts not properly tightened.
(4) Pinched or wrinkled gasket.
(5) Dirt on sealing surfaces.

6. *Liquid Flowing But Register Not Turning Over*

A. On all types of new and old meters
(1) A broken register part or badly worn parts can shear off one of the drive spindle pins.
(2) The by-pass around meter can be fully open.
(3) On outside installations, look for ice in register which can shear off pins.

When ordering replacement parts, give the manufacturer the serial number, model number, and the size of meter or meter accessories, as well as name and number of part. Double check prior to mailing of order.

When procuring meters and accessories for corrosive liquids such as acids, brines, etc., supply the meter manufacturer with detailed information on the liquid and the

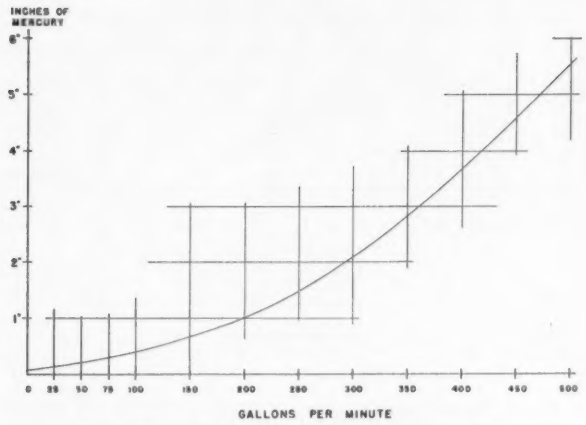


Fig. 4. Pressure loss vs. rate of flow (gasoline).

system so that the most suitable equipment will be recommended.

Typical Installation

A typical installation is shown in Fig. 2.

1. *Strainer*

The strainer is a simple but important device in a metering system. It prevents dirt and foreign particles from entering and damaging the meter. The foreign particles are trapped and accumulated in a basket.

A. The strainer should be installed as close as possible to the meter.

B. If it is necessary to provide piping between meter and strainer, this pipe should be cleaned thoroughly to remove pipe scale and other foreign matter. If these particles are not removed, they could score the internal parts of the meter.

C. It is important to provide space so that the strainer basket can be easily removed and cleaned. A clogged strainer basket could cause reduced rate of flow of the metering system. The cleaning cycle depends on the amount of contaminants in the system or product.

D. The cleaning cycle will be more frequent on new installations until the system is flushed clean of foreign matter in pipes and tanks.

E. The strainer body and basket must be manufactured of suitable materials to avoid chemical and electrolytic corroding and discoloration of the liquid.

F. The meter manufacturers can furnish strainer baskets with fine or coarse mesh screens.

2. *Air Eliminator*

The Air Eliminator is a device for separating and releasing air and vapors from the flowing liquid.

A. The Air Eliminator should be installed as close to the meter as possible (to remove practically all air just prior to metering).

B. A positive-displacement meter will measure and register entrained air; therefore, it is important to remove all air from the liquid to insure accuracy.

C. The Air Eliminators shall be of suitable materials.

D. The air vent line from the Air Eliminator must be of sufficient size to permit the free flow of air to atmosphere.

E.The air vent line may be connected to a drum to collect possible drippings or returned to the storage tank. The latter is used when the tank is conveniently located and is vented to atmosphere.

3. *Meter*

Meters are manufactured to withstand normal loading

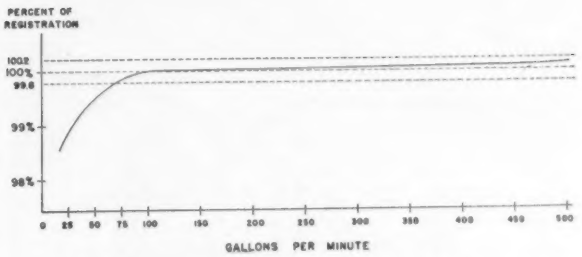


Fig. 5. Accuracy vs. rate of a flow for a Rotocycle meter.

and wear conditions. They are precision instruments and should be treated as such.

A. As mentioned, the inlet piping to the meter should be thoroughly cleaned.

B. The meter always should be installed to prevent draining of the measuring chamber. Therefore, it should be trapped or the back-pressure valve installed on the outlet side of the meter to prevent draining of the measuring chamber.

C. It is important to avoid the installation of a by-pass connection around the meter. Valves in the by-pass lines can accidentally be left open, can work open, and can leak.

D. The inlet and outlet piping to the meter must be level and secure to prevent distortion of meter housing.

E. The meter should be protected against pipe expansion due to change in ambient and liquid temperature; use swing joints or a regular expansion fitting. For liquids having a high coefficient of expansion, use a check and relief valve in the system to relieve the excess pressure due to the increased volume.

F. After properly installing the metering equipment, the system must be freed of air. The meter should be operated slowly in removing this air to avoid line shock.

G. Upon removing the air from the system, check the rate of flow. If the maximum rate of flow exceeds the rated capacity of the meter, a flow control device should be installed on the downstream side of the meter and adjusted to the desired rate of flow.

H. On many positive-displacement-pump systems, the pump by-pass can be adjusted to attain maximum rate of flow for a minimum amount of pressure.

I. On liquids having high vapor-pressure, the throttling of the system must always be accomplished on the downstream side of the meter. If throttled on the upstream side the liquids might vaporize at the throttling point, causing over-registration. It is important on liquids of this type to properly size the pipe to attain the desired rate of flow and to prevent vaporization of the liquid.

J. A meter of suitable materials must always be selected.

K. On many applications it is advisable to consult the manufacturer or their representative for assistance in selecting the meter and accessories.

L. Meter manufacturers have made great strides in the meter design in the past few years; liquids are being metered today that were formerly thought impossible.

Typical Test Arrangement

It is important to check periodically the accuracy of all meters. Meters measuring products to retailers and consumers usually are checked by the Sealer of Weights and Measures and must conform to standards established by the Bureau of Standards, Washington, D. C. Accuracy also is important on meters used for processing of liquids

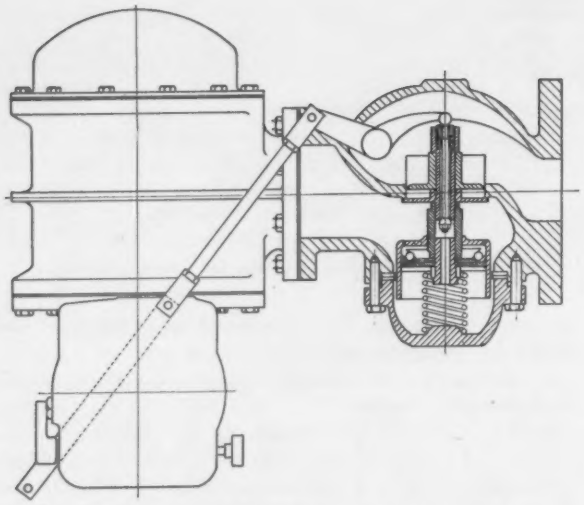


Fig. 6. Section of multi-stage quantity-control valve.

because slight errors could mean the spoiling of a large quantity of the end product.

The two most commonly used systems for checking meter accuracy are the so-called *permanent* and *portable* systems; both are used for checking marketing and industrial meters. The permanent system is most common in industry; the portable is most common in marketing. The permanent system is the more expensive of the two for checking marketing meters, but is less expensive for industrial meters. The portable system for marketing meters simulates closely the conditions under which the product is normally delivered, whereas the permanent system usually simulates industrial meter applications.

Prover Tanks

The prover tank, permanent or portable, should be procured from tank manufacturers with the manufacturing know-how. If manufactured by the user, they must be manufactured in accordance with proven designs. The tanks should be checked periodically for accuracy. It is best to avoid improvised prover tanks or systems.

The size of the prover tank depends on the meter size. The capacity should be equal to the maximum rate of flow of the meter for a duration of one minute. For example, if the maximum rate of the meter is 500 gpm, the prover tank should have a minimum capacity of 500 gallons.

We recommend bottom filling of prover tanks of large capacity. This permits faster filling, eliminates foaming, and keeps vapor loss at a minimum.

Important points of a prover system are as follows:

1. The prover tank must be level.
2. Meter should be tested in its normal operating position if possible.
3. The viscosity of the test liquid should be close to that of the metered product; difference in viscosity will affect accuracy.
4. The meter should be close to the prover tank.
5. The throttling valve should always be on the downstream side of the meter to guard against vaporizing liquid.
6. A quick-opening-and-closing valve should be used in discharge line to start meter as fast as possible and to stop meter on the desired quantity.
7. A quick-opening-and-closing valve also should be used on prover-tank discharge line to control the draining time and to reduce time of test cycle.

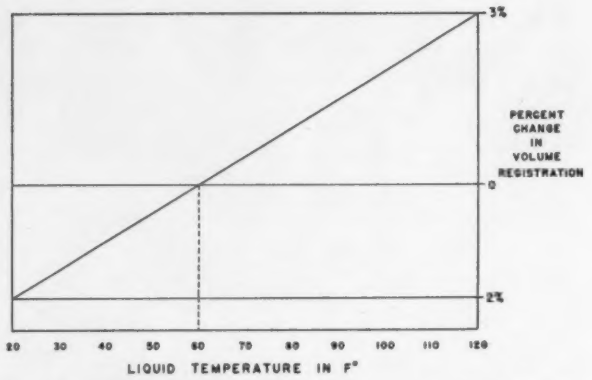


Fig. 7. Percent change in volume registration vs. liquid temperature for a liquid with coefficient of expansion of 0.0005.

8. The prover tank should be 100-percent wetted before checking meter accuracy; on wetting the tank the meter register should be ignored. There is always a certain amount of clingage of the liquid to the prover tank, and the clingage will not change on subsequent tests.
9. The drainage time of the prover tank shall be the same on all tests. This will assure uniform results.

Important points of a test are as follows:

1. Start with a wetted tank.
2. Reset register to zero.
3. Test meter at its maximum and minimum rates of flow.
4. Operate the meter to the quantity on the register equal to the prover-tank capacity.
5. Record the average over or under delivery in percentage or cubic inches. This is taken from the calibrated plate on the prover tank.
6. Repeat tests as much as four times to eliminate human error.
7. The percentage of error should be the same at maximum and minimum rates of flow because the performance curve retains its shape on all meters. If these results are attained, the meter can be adjusted to 100 percent. If the error is different at maximum and minimum rates of flow, this means that something mechanical is wrong with the device. Check for dirt, worn parts, etc.
8. If the temperature of the liquid changes from the time it passes through the meter and when the tank is read, it is advisable to make temperature corrections.
9. It is a good policy to check pressure drop across meter to determine if the meter is functioning properly.

Pressure Loss at Rate of Flow

A typical pressure loss curve is shown in Fig. 4. This curve is representative of pressure loss of Rotocycle meters on gasoline service.

The curve is smooth and continues to rise as the rate of flow increases because liquid power (line pressure) is required to overcome liquid and mechanical friction. This friction increases with speed and, therefore, more power is required at the increased rates of flow. (Note: 2.05 inches Hg equals 1 psi.)

Accuracy

A typical accuracy curve of a Rotocycle meter (Fig. 5) illustrates that the meter was accurate within 0.2 percent from 75 gpm minimum to 500 gpm maximum (maximum capacity of meter). The minimum is 20 percent of maximum, or 100 gpm. The minimum rating established by Sealers of Weights and Measures.

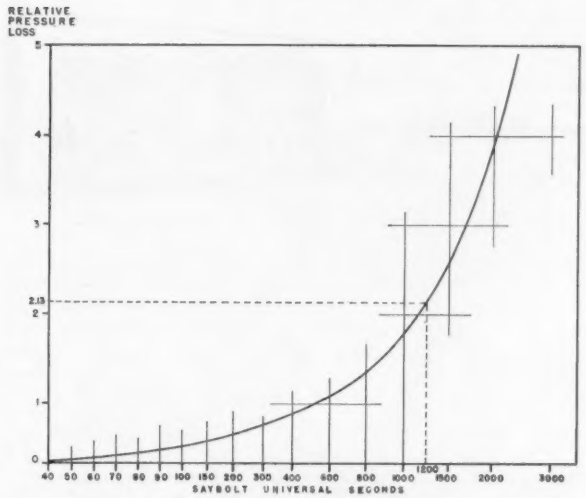


Fig. 8. Pressure loss across meter vs. viscosity. Dotted lines show that if a meter is measuring gasoline at a pressure loss of 2 psi, the pressure loss when measuring oil of 1200 SSU viscosity, at same rate of flow, will be 2.13 greater, or 4.26 psi.

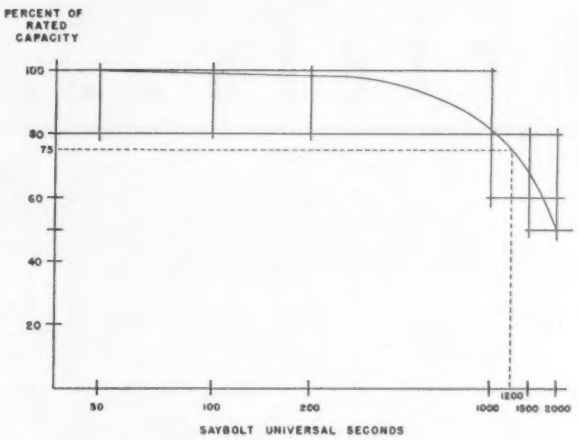


Fig. 9. Rated capacity vs. viscosity. Dotted lines show that maximum meter rating for oil with viscosity of 1200 SSU is 75 percent of the rating for gasoline. Hence meter with rating of 200 gpm gasoline will have rating of 150 gpm for the oil.

The curve drops off sharply at 75 gpm and falls rapidly to 0 gpm because at 75 gpm we experience more movement of liquid through the clearances around the displacement members. This leakage becomes proportionately greater as the rate of flow drops off.

The curve is practically level from 75 to 500 gpm because a good capillary seal is effected around the displacement members.

Quantity Control Equipment

Many positive-displacement meters are equipped to deliver automatically a definite quantity of liquid, as with meters used to load and unload tank trucks, barges and railroad tank cars, industrial batching operations, etc. The Quantity Control Equipment consists of meter, predetermining register, latch mechanism, valve, and small or large reset register.

The valve illustrated in Fig. 6 is a new development by Rockwell Manufacturing Company—the Type "744" Multi-stage Quantity Control Valve. The valve is designed to eliminate line shock and to obtain accurate measurements. The closing movement of the valve is in three stages, and the closing cycle begins when a few gallons of the preset quantity remain to be delivered. For example, on the 4-inch size, rated at 500 gallons per minute, the closing cycle starts at 29 gallons left to be delivered, and the second trip occurs at the remaining 5 gallons. The final trip occurs when the full preset quantity has been delivered. The rates of flow at the three stages are full open—500 gpm; second trip—150 gpm; third trip—50 gpm. The closing time is approximately 8½ seconds. This valve will be available in 2-, 3-, 4-, and 6-inch sizes and for rates of flow of 5 to 800 gpm.

The predetermining register is equipped with an emergency trip for stopping the flow at any point during the delivery of the preset quantity. The valve opens freely if no effort is made to open it quickly; a five-pound pull will open the 4-inch valve with a line pressure of forty-five psi.

The valve consists of a spring-loaded pressure-balanced poppet provided with a centrally-located small pilot valve for free opening and slow closing. The balancing feature is accomplished by means of a sealed piston attached to the poppet and operating in a partially sealed cylinder. The liquid pressure assists in opening the valve, and the speed of closing is controlled by the size of openings in the partially sealed cylinder.

Effect of Temperature on Liquid Volume

The specific volume and density of any liquid vary with the temperature of the liquid. To establish the value of a given volume of a liquid without converting it to weight, the volume must be corrected to a standard base temperature. To make this correction automatically, a pressure thermometer is inserted in the liquid line to vary the setting of a micro adjustment. The meter then can handle liquid at any temperature within the range of the temperature compensator, and the volume corrected to a standard base temperature is recorded on the register. Fig. 7 shows a typical chart for a liquid having a coefficient of expansion of 0.0005.

The temperature range of the pressure bulb is 20 to 120 deg. F., a difference of 100 deg. F. Therefore, the maximum change in volume on 100 gallons is 5 gallons (0.0005 x 100 gallons x 100 F.).

Note that no correction is required at 60 F., (the base temperature), but at 120 F. the volume changes by 3 percent of the volume at 60 F. In other words, the register must record 3-percent less volume than the actual volume thruput of meter.

Effect of Viscosity and Rate of Flow

Most marketing and industrial positive-displacement meters are designed to give an accuracy of plus or minus 0.2 percent of the rated capacity. Close clearances are necessary to maintain this accuracy on metering non-viscous products such as gasoline, kerosene, etc.

The pressure loss increases on these meters as the viscosity of the product increases (Fig. 8) because the fluid friction is higher and more work is required to shear the liquid film in the meter clearances.

The pressure loss also increases as the rate of flow increases (Fig. 9). The amount of increase depends entirely on the metering principle and the design of the metering device.

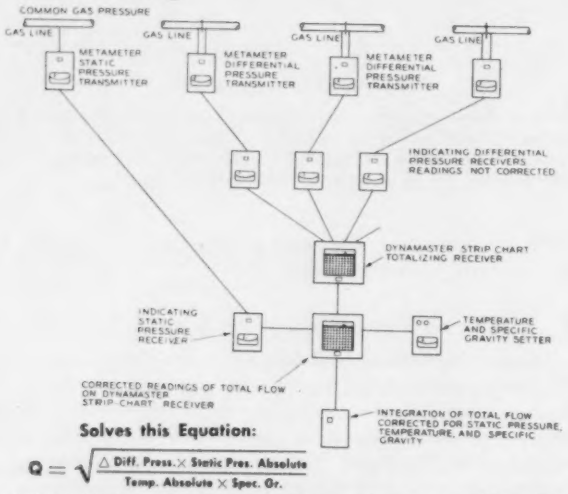
If the viscosity of the product is high, the meter should be designed with greater clearances. This will reduce the work within the meter, thereby obtaining a greater rate of flow at a lower pressure loss.

It may be desirable to handle highly viscous liquids at elevated temperatures; meters for this type of service should be steam jacketed or maintained at the proper temperature by some means.

Briefs . . .

INSTRUMENTS and AUTOMATION

Telemetering—Totalizing—Correcting

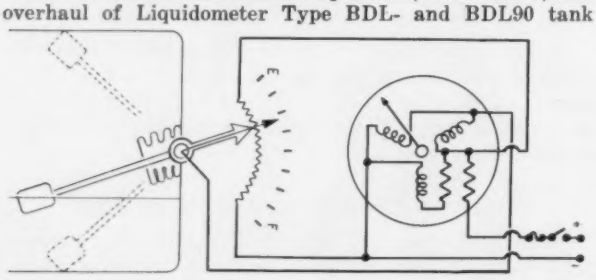

COMMON GAS PRESSURE
GAS LINE
METAMETER STATIC PRESSURE TRANSMITTER
METAMETER DIFFERENTIAL PRESSURE TRANSMITTER
INDICATING DIFFERENTIAL PRESSURE RECEIVERS, READINGS NOT CORRECTED
DYNAMASTER STRIP CHART TOTALIZING RECEIVER
INDICATING STATIC PRESSURE RECEIVER
TEMPERATURE AND SPECIFIC GRAVITY SETTER
CORRECTED READINGS OF TOTAL FLOW ON DYNAMASTER STRIP-CHART RECEIVER
INTEGRATION OF TOTAL FLOW CORRECTED FOR STATIC PRESSURE, TEMPERATURE, AND SPECIFIC GRAVITY
Solves this Equation:
$Q = \sqrt{\frac{\Delta \text{ Diff. Press.} \times \text{Static Pres. Absolute}}{\text{Temp. Absolute} \times \text{Spec. Gr.}}}$

(This) Metameter telemetering equipment totalizes flow of gas through many pipes, and corrects for pressure, temperature, and specific gravity. (*From* 44-*page Bulletin M*1710, *The Bristol Co., Waterbury* 20, *Conn.*)

For this literature circle **501** on inquiry card.

Liquidometer Tank Gage

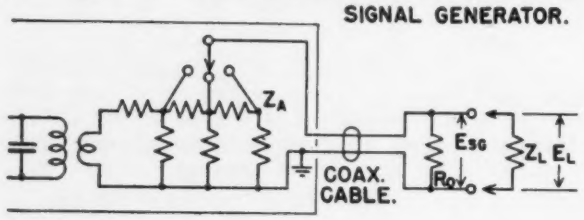
This handbook describes the operation, installation, and overhaul of Liquidometer Type BDL- and BDL90 tank contents gage and remote indicators. . . . The float follows the position of the liquid level. . . . The transmitting system consists of a resistance strip and a wiper arm. . . . The remote indicator contains a jewel-mounted magnetized rotor surrounded by three electromagnets. (*From new* 46-*page Handbook No.* 426, *The Liquidometer Corp., Skillman Ave. and* 36 *St., Long Island City* 1, *N. Y.*)

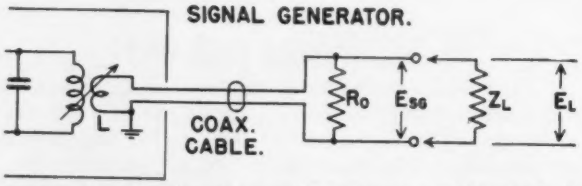


For this literature circle **502** on inquiry card.

Signal Generator Impedance

Users of Signal Generators often question the true value of voltage developed across the input of the receiver under test. They are also confused when the apparent sensitivity



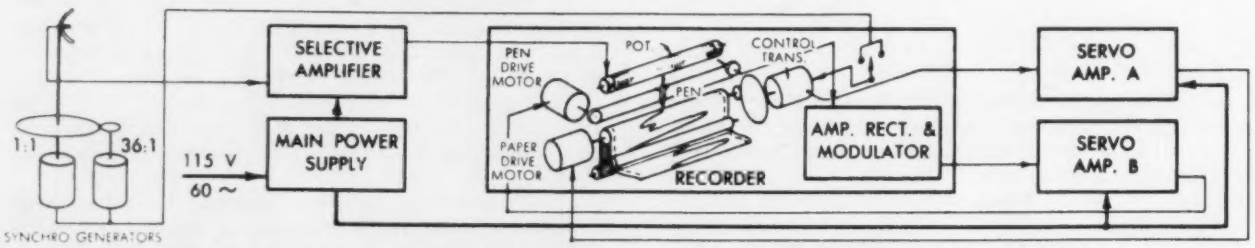


appears to be a function of the generator with which the measurement is made.

Measurements made with different generators can usually be correlated if consideration is given to: (1) output impedance of the generator, (2) possibility of standing waves on the output cable, (3) effect of load impedance, (4) resonance in leads used to connect generator to load.

The output circuit of the modern signal generator is designed for use with a transmission line output cable. That is, the output terminals, instead of appearing on the front panel, are placed at the extremity of a coaxial cable thereby permitting the use of extremely short leads between generator and load. This cable functions as a transmission

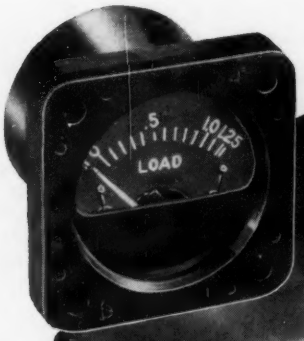
Rectangular-coordinate Recording



The AIL Rectangular Coordinate Recording System provides a continuous inked plot of the logarithm of input voltage as a function of angular position or time. Features: full-scale pen deflection in ¼ second. Dynamic error at maximum writing speed—± 0.4 db. Chart positioning system—accurate to ± 0.1 inch at maximum speed. Sensitivity—equivalent to internal noise level less than 1 microvolt referred to input of recording system. Range—80 db range of recorded voltage. (*From new* 4-*page brochure, Airborne Instruments Laboratory, Inc.,* 160 *Old Country Rd., Mineola, L. I., N. Y.*)

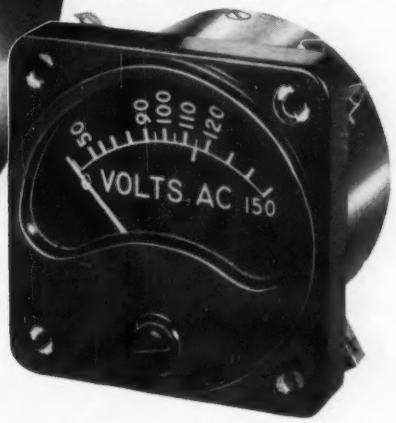
For this literature circle **503** on inquiry card.

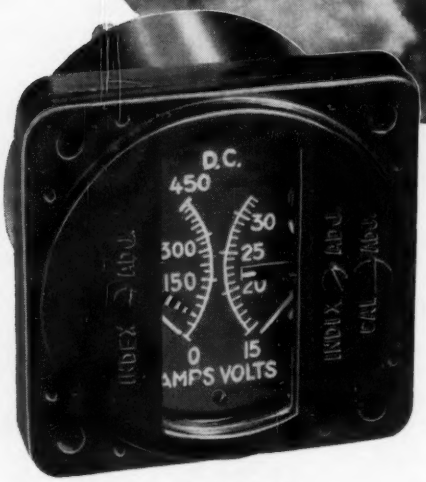
AIRCRAFT LOAD METER
Range: 50 MV, Arbitrary scale in LOAD. Used in conjunction with external shunt to measure load on DC aircraft systems.



The SKY'S the Limit!

AIRCRAFT VOLTMETER
Range: 150 VAC
Supplied in 400 cycle, 350-1000 cycle, 800-1400 cycle frequencies.





DUAL VOLT-AMMETER
Ranges: 15-33 volts—0-150, 0-300, 0-450 amperes. This meter is produced exclusively by Roller-Smith.

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For more information circle **105** on inquiry card.

Boost 100 PSI. air pressure to 10,000 PSI. fluid pressure for $173.25 (FOB Gardena, Calif.). Eight standard models for output fluid pressures of 1,000 to 30,000 PSI. Special models for lower or higher pressures.

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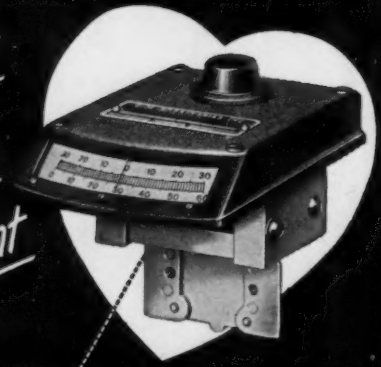

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BRIEFS—CONTINUED

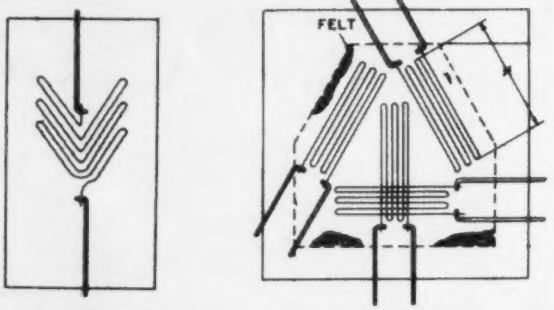
line and should be properly terminated at both ends for optimum performance.

Signal Generators are calibrated in terms of voltage appearing across the terminals of the output cable terminated by its characteristic impedance. The following examples will illustrate the errors that may be introduced by line characteristics and load impedances (for both resistive and mutual inductance attenuators.) (*From new 64-page brochure Catalog D, "Laboratory Standards," Measurements Corp., Boonton, N. J.*)

For this literature circle **504** on inquiry card.

Strain Gages

Single grid strain gages measure only those strains parallel to the strain axis. Transverse-axis sensitivity is generally less than 2 percent of the major-axis sensitivity.



Sensitive only to stress parallel to axis

"Rosette" gage

unique in design — rugged in construction

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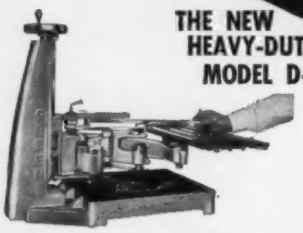
THE NEW HEAVY-DUTY MODEL D-2



The three-dimensional bench Model 106 cuts costs — engraves, routs, models and profiles, giving you expert results even by unskilled workers.

The Model D-2 two dimensional heavy-duty Pantograph is a precision machine with a multitude of new features. Open on three sides, it permits complete freedom for engraving, milling, profiling large panels (up to 30" in diameter) or bulky pieces. Single, micrometer adjustment controls vertical depth of cut, automatically adjusting copy table with pantograph. Range of reduction ratios from 2-to-1 to infinity! Vertical range over 10 inches!

For complete information, write to

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For more information circle **108** on inquiry card.

When strain directions are unknown . . . multiple arrays called "Rosette" gages are used.

Static or "quasi-static" work requires wire with a low temperature coefficient (1 x 10^{-5} ohms/ohms/deg. C). Such a wire has been developed under the trade name "Constantan."

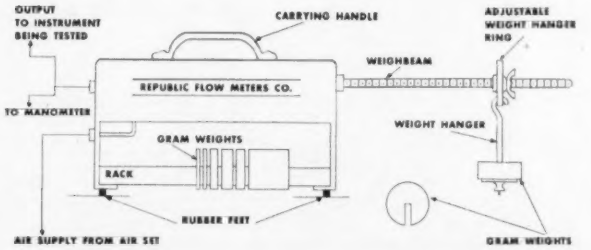
Work at high frequencies at low amplitudes requires wire of fatigue resistance and gages of high output, even at the sacrifice of long-term stability. For this, "Iso-Elastic" wire was developed. (*From 16-page Vol. 8 No. 3 issue of "CEC Recordings," Consolidated Engineering Corp., 300 N. Sierra Madre, Pasadena 15, Calif.*)

For this literature circle **505** on inquiry card.

Medium-pressure Calibrator

The Republic medium-pressure Calibrator is for fast, easy testing and calibration of pressure instruments operating between 20 in. H_20 and 25 psi. . . . The Calibrator eliminates the slow process of checking every setting with a manometer.

Essentially a weight controlled relay, the calibrator operates on the force balance principle. Weights on the weighbeam are counterbalanced by air pressure under a reaction bellows. The more weight on the weighbeam, the more will be the pressure under the bellows. Thus the bel-



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Linearity...1% f.s. maximum deviation
Hysteresis.....less than 1% of f.s.
Acceleration Response.....less than 0.13% of full scale per g
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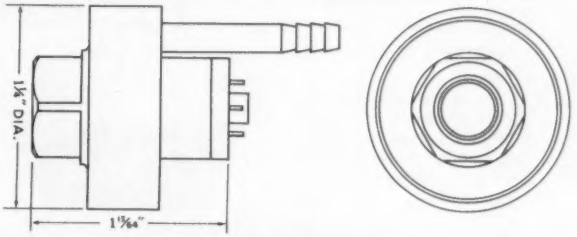
Pressure Connection.....⅛ npt Internal Thread

A **complete** calibration certificate sent with every unit.



Send for pickup Bulletin CEC-1556-X4.

Consolidated Engineering CORPORATION
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For more information circle **110** on inquiry card.

GENERAL CONTROL SWITCHES

MULTIPLE PUSH BUTTON SWITCHES

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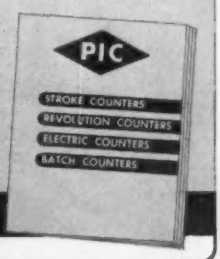

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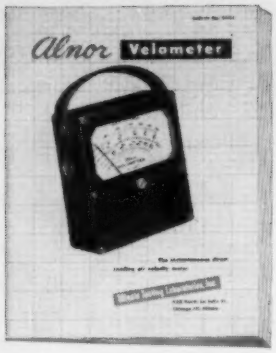

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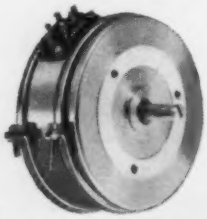

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lows pressure can be made to correspond to accurate weights. This pressure is conducted to instruments to be calibrated. (*From new 2-page Form 53-3, Republic Flow Meters Co., 2240 Diversey Pkwy., Chicago 47, Ill.*)

For this literature circle **506** on inquiry card.

100,000 PSI

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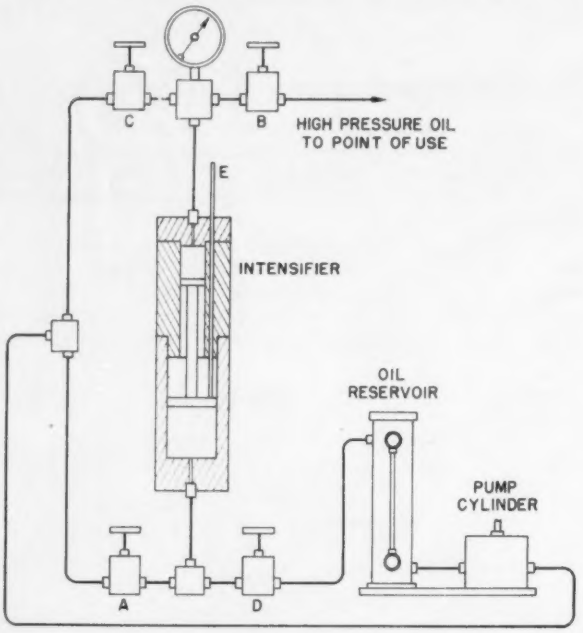

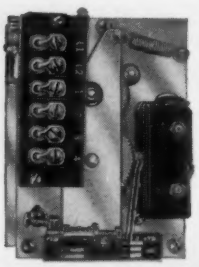

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DELAY TIMERS

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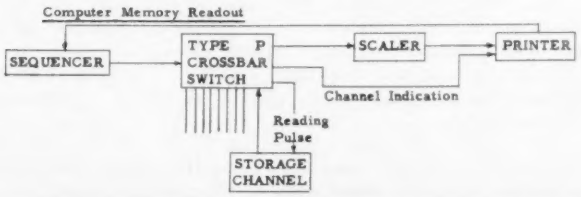
The intensifier consists of a double piston-cylinder arrangement as shown in the sectional view. Oil is pumped into the large cylinder by means of a hand hydraulic pump or other means, and oil is expelled from the small cylinder at a higher pressure, dependent upon the area ratio and friction. (*From new 104-page catalog "Aminco Superpressure Equipment," American Instrument Co., Inc., Silver Spring, Md.*)

For this literature circle **507** on inquiry card.

Crossbar Switch Applications

The crossbar switch allows each circuit of a group of circuits to be connected to a circuit or circuits of another group of circuits in any combination. . . . The crossbar switch is operated by electro magnets which set up and hold connections. Circuit connections are set up one at a time by two separate and successive operations.

The crossbar switch is constructed of a number of line plates mounted in a rigid frame. The line plate assembly carries the line conductors and hold magnets. The link conductor channels extend through the line plates at right angles. The line plates are on .750" centers and the link conductor channels on .890" centers. . . . The Cunningham Crossbar Switch has numerous applications in telephony, telegraphy, inter-communication and computer systems. (For example) this system automatically scans the contents of a series of storage channels of a computer



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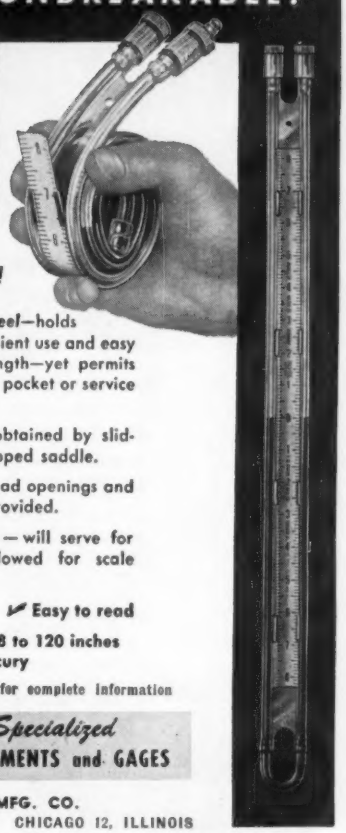

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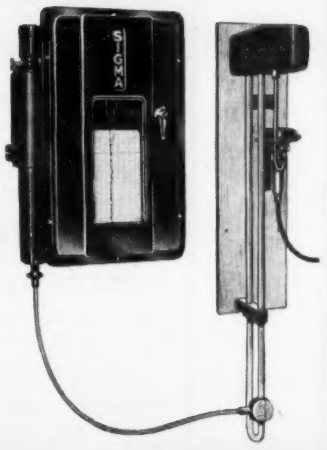

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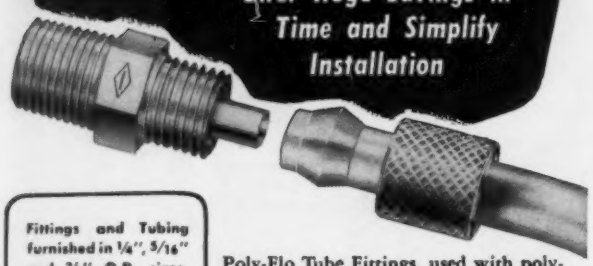

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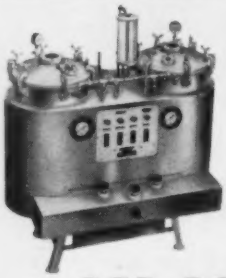

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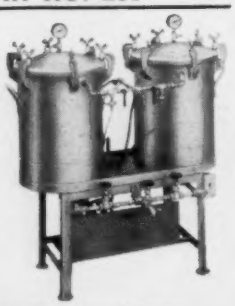

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or similar device. (*From new 4-page Brochure 10MCH453 and 7 Application Sheets, James Cunningham Son & Co., Inc., Rochester 8, N. Y.*)

For this literature circle **508** on inquiry card.

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The relays depicted in this catalog are subminiature types, hermetically sealed . . . . thoroughly degassed and nitrogen filled at a pressure of one atmosphere.

The following block diagram illustrates a method of testing a relay's contacts for reliable switching of several microamperes.

The signal generator forces several microamperes through R1 and R2 (when the relay contacts are all in the normally closed or transferred to the normally open posi-

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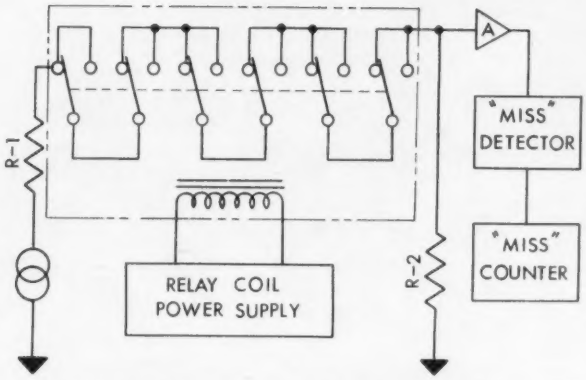

tion). "A" amplifies the voltage across R2 and transmits the amplified voltage to the "miss" detector. If all the relay contacts are functioning properly, the "miss" counter remains inoperative. . . . Recorded data indicate that a relay which has operated 40,000 times without a single "miss" can be expected to continue this "non-miss" behavior for up to 1,000,000 operations. Test results indicated that Filtors, Inc. relays have operated 1,000,000 consecutive times without a single "miss". (*From new 20-page brochure, Filtors, Inc., Electroquipt Div., Port Washington, N. Y.*)

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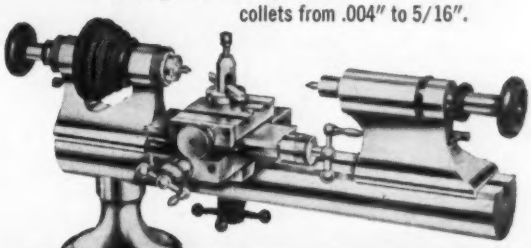

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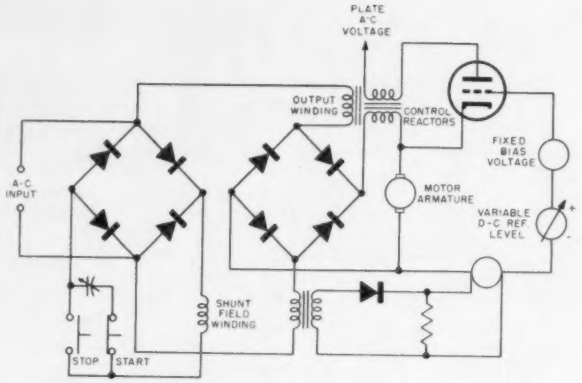

electrical and physical descriptions of selenium and copper-oxide rectifiers.

A major application of magnetic amplifiers is the control of an a-c motor in a servo system. (*From new 128-page "Metallic Rectifier Manual," Bradley Laboratories, Inc., New Haven, Conn., Price*: $2.00.)

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Circuit Breaker Engineering Guide

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that a fine quality control laboratory could be established in your plant for less than $5000? (*From new booklet "Quality Control & Research," Scientific Apparatus Makers Assoc., 20 N. Wacker Dr., Chicago 6, Ill.*)

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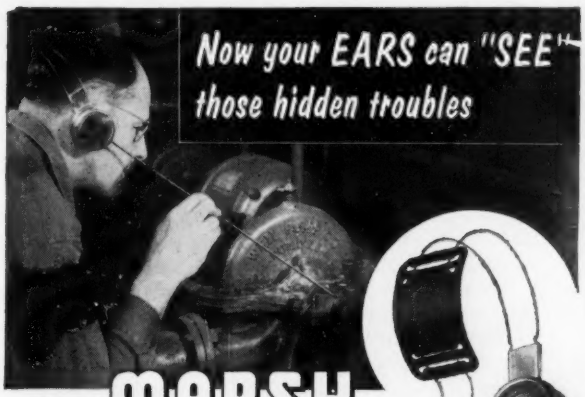

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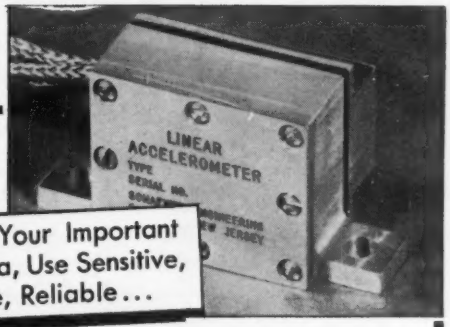

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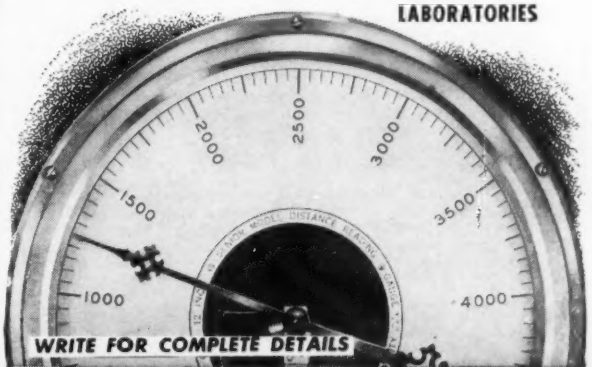

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See Page 477 for Answers

All Questions are based on editorial matter in this issue.

Question 1

In using a boiling-water reference bath the temperature of the bath is affected by

(a) barometric pressure only
(b) water composition only
(c) both barometric pressure and water composition
(d) neither barometric pressure nor water composition

Question 2

Barometric pressure at sea level is

(a) 760 mm Hg
(b) 29.92 in. Hg
(c) 14.7 psia
(d) all the above

Question 3

Which of the following statements about a radiation blackbody is NOT true?

(a) It absorbs all the radiant energy incident upon it.
(b) It is the only body for which the relation between the intensity of its radiant energy and its temperature is known.
(c) Dark objects are perfect blackbodies.
(d) It is used as a radiation standard.

Question 4

In strip pickling it is necessary to measure and control the addition of acid to the pickling tanks. Which of the following statements about control of the acid addition is NOT true?

(a) Pipes, valves, and instruments handling acid should be of stainless steel.
(b) Acid is proportioned to water addition.
(c) Facilities for batch

How's your

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The Electronic Control Handbook by R. R. Batcher & Wm. Moulic, 1952, paper, 244 pages. Price $3.00 ☐

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Applications of Industrial pH Controls by Allen L. Chaplin, 1950, cloth, 4½" x 8", 144 pages. Price $2.50 ☐

Maintenance and Servicing of Electrical Instruments by James Spencer, Third Edition 1951, cloth, 4¾" x 8¼", 256 pages. Price $3.00 ☐

Mechanical Measurements by Electrical Methods by Howard C. Roberts, Second Edition 1951, cloth, 4¾" x 8¼", 537 pages. Price $4.00 ☐

Operation and Care of Circular-scale Instruments by James Spencer, 1949, cloth, 4½" x 8", 90 pages. Price $1.50 ☐

and continuous addition of acid should be available.

(d) Batch control is used for tank make-up, and continuous control for maximum efficiency.

Question 5

Which of the following statements about the McIlroy Fluid Network Analyzer is NOT true?

(a) It is essentially an analog computer.
(b) Fluistors simulate the fluid flow.
(c) Pressure is simulated by voltage.
(d) Fluistors are nonlinear resistors.

Question 6

Which of the following statements about checking positive-displacement meters for liquid service is NOT true?

(a) Both permanent and portable proving systems are used for both marketing and industrial meters.
(b) Both permanent and portable systems use prover tanks.
(c) Prover tanks need be calibrated only when installed.
(d) Accuracy of most marketing and industrial types is about plus or minus 0.2 percent.

Question 7

The major constituents of the air at the earth's surface are

(a) nitrogen and oxygen
(b) hydrogen and oxygen
(c) carbon dioxide and oxygen
(d) hydrocarbons and oxygen

Question 8

Ozone is

(a) Z_2
(b) CO
(c) O_2
(d) O_3

Question 9

Normal concentration of ozone in the air at earth's surface (in parts per hundred million) is about

(a) 0.1
(b) 5
(c) 5000
(d) 5 x 10^6

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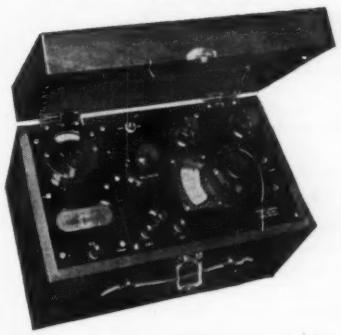

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New Literature...

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AUTOMATION

Automation Dictionary. New 20-page "Automation Dictionary" G-84 defines words and phrases used in automation field.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila., Pa.

Circle **514** on inquiry card.

Process Controllers. New 4-page Booklet ND46-33 (103) describes maker's "Speedomax Type H" position-adjusting controllers for heat-treating, baking and drying applications.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

Circle **515** on inquiry card.

Process Instrumentation. Five new Data Sheets ND46-33 (100 to 104) describe and illustrate maker's "Speedomax Type H" indicator and indicating recorders, two-position, proportional action, position-adjusting and duration-adjusting type controllers.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **516** on inquiry card.

Meter Controller. New 2-page brochure presents maker's Models 360, 360 H, and 361 H meter controllers (D'Arsonval movement plus relay contact) for process control and monitoring.—Daytronic Corp., 216 S. Main St., Dayton, Ohio.

Circle **517** on inquiry card.

Servo Amplifiers. Two new 2-page bulletins describe maker's "Model 434-B, 463-B and 472-B" transistor-magnetic-amplifier servoamplifiers for medium-performance positional loops where zero maintenance and absolute reliability are paramount.—Industrial Control Co., Wyandanch, L. I., N. Y.

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Electromechanical Amplifier. New 4-page booklet describes maker's electromechanical amplifier, a proportional dual-differential powder-clutch-controlled servomechanism for control of machines and mechanisms where a rotating device is employed as a scource.—Electomic Designs, P. O. Box 1156, Greenwich, Conn.

Circle **519** on inquiry card.

Plating Tank Control. New 4-page Leaflet 8267D describes maker's "Solu Bridge" automatic rinse-tank control system which continuously measures degree of conductivity present in a solution, and permanently maintains a selected control point.—Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.

Circle **520** on inquiry card.

Circuit Controlling Counter. New 8-page Bulletin 505 describes and illustrates maker's "Programonitor" multi-stage circuit-controlling counter with automatic recycling.—Counter and Control Corp., 5225 W. Electric Ave., Milwaukee 14, Wisc.

Circle **521** on inquiry card.

Water Works Equipment. New 4-page Technical Memo BIF-M3 describes and illustrates water works equipment and instrumentation check list for engineers. Includes flow diagrams for various water works systems.—B-I-F Industries, Inc., 345 Harris Ave., Providence 1, R. I.

Circle **522** on inquiry card.

Pilot Relay. New 2-page bulletin describes maker's electronic pilot relay "Model EB" for controlling large values of current and power with a current flow of 2 micro-amperes.—Industrial Electronic Controls Co., 2271 East 14th St., Brooklyn 29, N. Y.

Circle **523** on inquiry card.

Production Vial Filler. New 2-page bulletin describes and illustrates maker's "Filamatic Duplex" a double-nozzle production filler, variable-rate metering pump, and two-stage vial filler.—Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

Circle **524** on inquiry card.

Arc Furnace Control. New 4-page Bulletin 162 describes maker's furnace electrode control for hydraulically-positioning arc furnace electrodes.—Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.

Circle **525** on inquiry card.

Moisture Control. New 4-page issue of "Humidity Engineer" (Vol. 5, No. 4) features article on "Blast Air Moisture Control Improves Cupola Irons."—Surface Combustion Corp., Toledo 1, Ohio.

Circle **526** on inquiry card.

Machine Control, Gaging. New 12-page Catalog AU-1154 presents application and engineering data on maker's control units for automatic machine control, gaging, classifying, and segregating processes.—Sheffield Corp., Dayton 1, Ohio.

Circle **527** on inquiry card.

Automation Equipment. New 16-page Brochure SDD 230 pictures and describes maker's automation equipment including remote control and indicator console, facsimile plotter and computer, electronic color scanner, special-purpose machine-tool computers, etc.—Austin Co., 76 Ninth Ave., New York City 11, N. Y.

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Sectionized Automation. New 18-page illustrated booklet 659 presents description of maker's "Transfermatic" sectionized automation, completely integrated production line that permits shutting down of some operations without interrupting production.—Cross Co., Detroit 7, Mich.

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Machine-Tool Automation. New 12-page catalog describes and illustrates maker's automation, mill-balancing, and transfer machine tools; center column and special machines for drilling, reaming, tapping, boring, turning, milling and mill-balancing.—Snyder Tool & Engineering Co., 3400 E. Lafayette Ave., Detroit 7, Mich.

Circle **530** on inquiry card.

Hydraulic Control Manifolds. New 4-page bulletin describes operation and applications of maker's hydraulic control manifolds for control of hydraulically-operated equipment.—Almo Tool Co., 11470 Kaltz, Centerline, Mich.

Circle **531** on inquiry card.

Variable-Speed Controls. New 8-page Catalog 88-55 presents maker's indexing turntables and variable-speed controls.—Eisler Engineering Co., Inc., 750 S. 13th St., Newark 3, N. J.

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VALVES

Valves. New 64-page Catalog 654 describes and illustrates maker's needle, globe, plug, check, relief, selector, aviation, industrial and special valves for hydraulic, lubricating, fuel, steam and other fluid systems.—Republic Manufacturing Co., 15655 Brookpark Rd., Cleveland 11, Ohio.

Circle **533** on inquiry card.

Solenoid Valve. New 12-page Brochure 215 presents description of maker's "Electro-Mite" combination solenoid valve, flow rate control and inlet strainer. Includes flow rate charts and specifications.—Hays Manufacturing Co., West 12th St., Erie, Pa.

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Steam Traps. New 8-page Bulletin 255A describes maker's thermodynamic steam traps for high pressure and superheated steam mains.—Sarco Co., Inc., 350 Fifth Ave., N. Y. 1, N. Y.

Circle **535** on inquiry card.

Slurry Control Valve. New 4-page bulletin describes maker's "Red Jacket" flexible-sleeve-type pneumatic-operated control valve for controlling pipe lines, slurry, sand, etc.—Red Jacket Co., Inc., 510 Investment Bldg., Pgh. 22, Pa.

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Valves, Cocks. New 8-page brochure describes maker's line of positive acting cock-type valves. Includes illustrations of eight types of cocks manufactured in standard pipe sizes with working pressures from 150 psi.—Mack Equipment and Machine Co., 327 N. Indiana Ave., Atlantic City, N. J.

Circle **537** on inquiry card.

Shut-Off Valves. New 4-page Bulletin M-302 presents operating and construction details, application examples and dimension tables on maker's "lock-tite" safety shut-off valves.—Eclipse Fuel Engineering Co., 1002 Buchanan St., Rockford, Ill.

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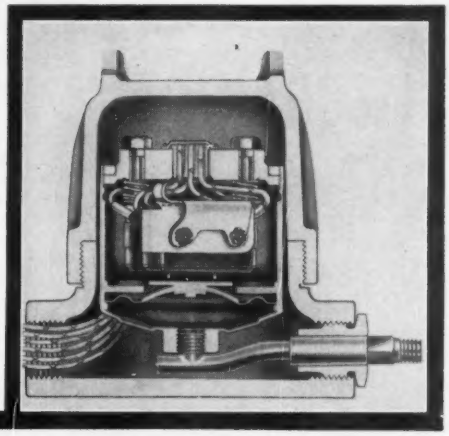

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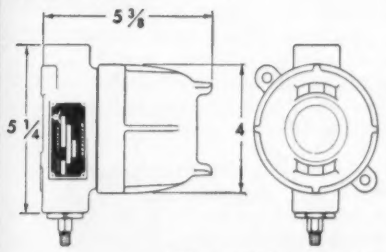

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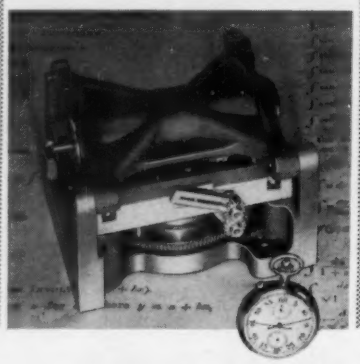

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MANUFACTURERS' NEW LITERATURE

MOTORS

Motors. New 8-page multi-color Booklet F 1878 illustrates maker's 20 principal types of motors, including uniclosed, totally-enclosed, explosion-proof, varidrive, syncrogear, vertical solid shaft, test stands, aircraft, etc.—U. S. Electrical Motors, Inc., Box 2058, Los Angeles 54, Calif.

Circle **539** on inquiry card.

Brake Motor. New 2-page Bulletin PM4-954 describes maker's 40-watt internal-brake motor for applications requiring high torque. Includes performance chart giving relationship between torque output and input amperes, speed, output watts, and percent efficiency.—Dalmotor Co., 1342 Clay St., Santa Clara, Calif.

Circle **540** on inquiry card.

Motor-Speed Controls. New 8-page issue of "Experimenter" (Vol. 29, No. 5) features article on "Unmounted Motor Speed Controls for Assembly into other Equipment."—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **541** on inquiry card.

POWER DRIVES

Hydraulic Cylinders. New 4-page Folder 3547 presents complete list of maker's air and hydraulic cylinders and boosters. Includes price list.—Miller Fluid Power Co., 2040 N. Hawthorne Ave., Melrose Park, Ill.

Circle **542** on inquiry card.

Adjustable-Speed Drives. New 8-page Bulletin SF1 presents construction details, capacities, characteristic torque curves, dimensions and efficiencies of maker's "Dynaspede" adjustable-speed-drive eddy-current couplings.—Dynamatic Div., Eaton Manufacturing Co., 3307 Fourteenth Ave., Kenosha, Wisc.

Circle **543** on inquiry card.

Power Steering Systems. New 4-page Catalog M 5106 presents maker's line of oil-hydraulic power-steering components for trucks, buses, material handling and other commercial type vehicles.—Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich.

Circle **544** on inquiry card.

TEMPERATURE

Thermoregulators. New 12-page brochure presents maker's line of (1) mercury thermoregulators featuring rising mercury and relay, (2) electronic Hi-Lo temperature alarm, (3) industrial and lab mercury-in-glass thermometers. New 2-page Catalog Sheets 15 and 20 describe new "Quick Set" thermoregulator with fingertip adjustment, and new "Signal Light" thermoregulator with colored-light indicator.—Philadelphia Scientific Glass Co., Abington, Pa.

Circle **545** on inquiry card.

Temperature System Tester. New 12-page brochure describes and illustrates maker's "Jetcal" jet engine temperature system tester that checks accuracy of thermocouple systems right on aircraft or on engine's production line in manufacture.—B & H Instrument Co., Inc., 1009 Norwood, Fort Worth 7, Texas.

Circle **546** on inquiry card.

Temperature Transmitter. New 8-page Bulletin 3302 describes and illustrates maker's "Nullmatic Model 33" temperature transmitter. Includes dimensions and specifications.—Moore Products Co., Phila. 24, Pa.

Circle **547** on inquiry card.

Temperature-Sensing Element. New 2-page bulletin describes maker's thermistor-type thermosensing element with high response speed for temperature measurement.—Kybernetes Corp., 1100 Raymond Blvd., Newark 5, N. J.

Circle **548** on inquiry card.

Industrial Thermometers. New 16-page brochure describes and illustrates maker's industrial thermometers, including straight form, back angle, right and left side angle, oblique angle, varnish kettle, sanitary dough and dairy thermometers.—Albert A. Weiss & Son, 263 Vanderbilt Ave., Brooklyn 5, N. Y.

Circle **549** on inquiry card.

Temperature Controller. New 2-page Bulletin MC-122 describes and illustrates maker's "Series 540" remote-indicating temperature controller for processing equipment, kilns, ovens and general industrial process control applications.—Fenwal, Inc., Ashland, Mass.

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Thermostat. New 2-page Brochure MC-122 presents performance specifications of maker's "Series 20000" liquid-filled, local-bulb thermostat for

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Circle **551** on inquiry card.

Industrial Ovens. New 4-page Bulletin 5510 presents description of maker's controller-indicator, recirculating-air draw furnace, lab muffle furnaces and recirculating ovens.—Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

Circle **552** on inquiry card.

Oil and Gas Burners. New 2-page Data Sheet 1-415 describes maker's "Series 630-P" combination oil- and gas-burners for radiant tube firing in controlled-atmosphere furnaces.—Hauck Manufacturing Co., 124-136 Tenth St., Brooklyn 15, N. Y.

Circle **553** on inquiry card.

Flexible Electric Heaters. New 4-page Bulletin T4-35C describes and illustrates maker's flexible heater for wrap-around and other heating applications.—Pre-Fab Heater Co., Guilford, Conn.

Circle **554** on inquiry card.

PRESSURE

Pressure Transducer. New 4-page bulletin describes maker's dual-element pressure transducer for translating static and dynamic air pressures to equivalent voltages.—Technology Instrument Corp., 531 Main St., Acton, Mass.

Circle **555** on inquiry card.

Draft Gage. New 4-page Brochure 52.1060.210 pictures and describes maker's "Vertiscale" draft gage that features 3-way cock, easy zero check, no parallax, removable units, dust-tight case, lucite scales, diaphragm operation, etc.—Hays Corp., 742 E. 8th St., Michigan City, Ind.

Circle **556** on inquiry card.

Pressure Switch. New 2-page bulletin describes maker's "Meletron Model 462" pressure-difference switch which senses pressure difference of 0 to 99 psi. between two pressures within working range of 0.05 to 100 psi.—Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle **557** on inquiry card.

Vacuum Regulator. New 2-page Data Sheet 10866R describes maker's "Micro-Set Manostat" for regulating and holding constant vacuum within 0.1 mm mercury pressure.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **558** on inquiry card.

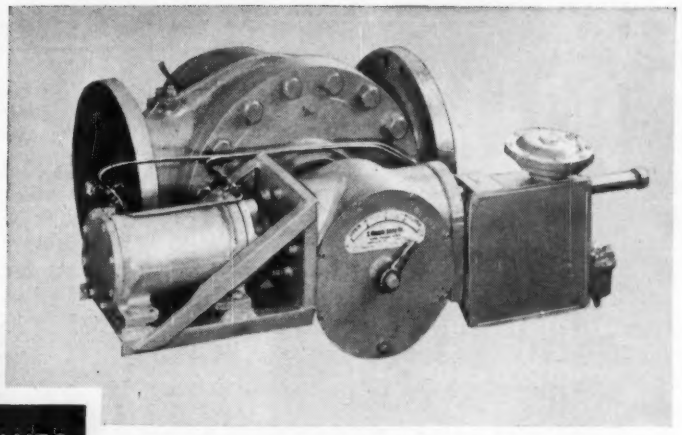
Leak Detector. New 16-page issue of "CEC Recordings" (Vol. 9, No. 1) features article on "24-110" leak detectors for detection of leaks in vacuum systems.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **559** on inquiry card.

FLOW

Rotameters. New 20-page Bulletin 115 presents description of maker's "Full-View" rotameters for flow measurement and control. Includes flow-capacity charts and details on design and construction.—Brooks Rotameter Co., Lansdale, Pa.

Circle **560** on inquiry card.



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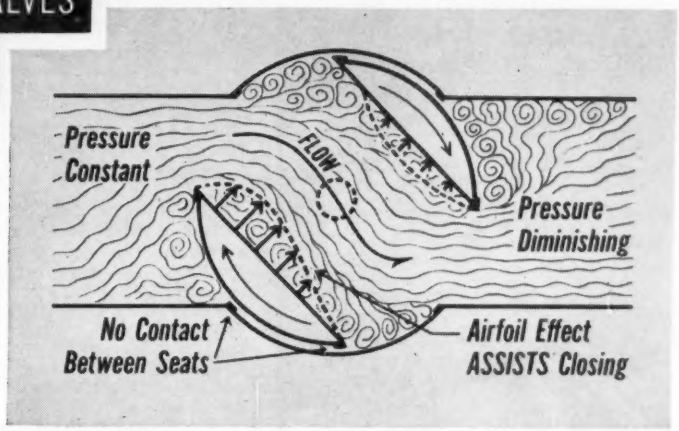

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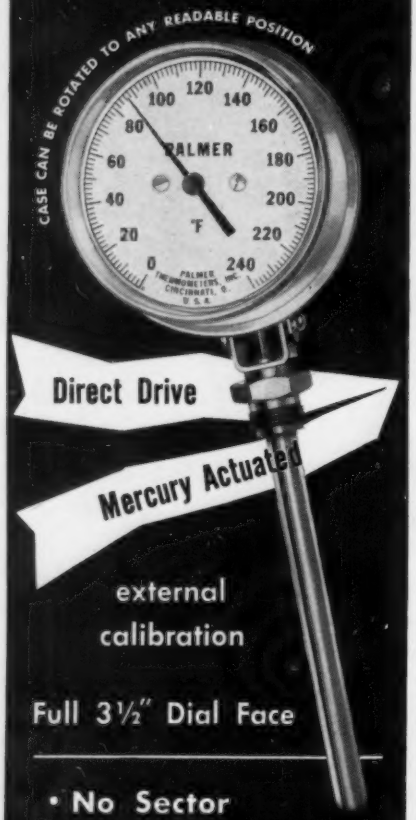

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NEW LITERATURE

Proportioning Systems. New 28-page Bulletin 0351 describes maker's "Select-O-Weigh" system for measuring and controlling pressure, tension, weight, etc. Includes photographs and engineering drawings illustrating installations.—Richardson Scale Co., Van Houten Ave., Clifton, N. J.

Circle **561** on inquiry card.

Chemical Blender. New 8-page Booklet SM-2070 describes and illustrates maker's "Model TC" blender for caustic dilution, asphalt blending, cutting of heavy fuel oil and blending of butane and gasoline.—Proportioneers, Inc., Providence 1, R. I.

Circle **562** on inquiry card.

Gas Feeders. New 12-page Bulletin 840-L29 describes and illustrates maker's chlorine gas feeders in treatment of industrial waste. Includes photographs, diagrams, tables and flow sheets.—Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.

Circle **563** on inquiry card.

Flow-Control System. New 4-page Data Sheet A-54-4 describes use of maker's controlled volume pumps for metering and controlling flow of several low-capacity chemicals for continuous polymerization of rubber.—Milton Roy Co., 1300 E. Mermaid Lane, Phila. 18, Pa.

Circle **564** on inquiry card.

RECORDING

Recording Charts. New 12-page bulletin presents description of maker's dial, rectangular and roll charts. Includes samples of dial and roll-type charts, and gives outlines of over 8000 different standard charts.—Technical Charts, Inc., 189 Van Rensselaer St., Buffalo 10, N. Y.

Circle **565** on inquiry card.

Cardiac Vectorscope. New 6-page leaflet presents description on maker's recording vectorscope for cardiac laboratory.—Technicon Cardiograph Corp., 215 E. 149th St., New York 51, N. Y.

Circle **566** on inquiry card.

Permanent Markings. New 4-page bulletin pictures maker's "Wrinlay Process" for application of permanent markings to panels, dials, chassis, schematics.—Photo Chemical Products, 479 Walton Ave., New York, N. Y.

Circle **567** on inquiry card.

Recorder. New 16-page Bulletin 541 describes and illustrates maker's "Tetco, Type R-500" recorder for permanent records of speed or production rate, plus totalization of production.—Electric Tachometer Corp., 2218 Vine St., Phila. 3, Pa.

Circle **568** on inquiry card.

COMPUTING, DATA PROCESSING

Magnetic Memory. New 8-page Bulletin 4310 describes maker's new "TapeDRUM" high-capacity rapid-access magnetic-storage device for data-handling applications such as inven-

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tory controls, processing of test data, etc.—Clevite-Brush Development Co., Cleveland 8, Ohio.

Circle **569** on inquiry card.

Data Processing. New 20-page Brochure 32-6448-0 describes maker's "705" electronic data-processing machine that can perform complete series of particularly-required operations through facilities of fast input and output, large-capacity magnetic-core memory and automatic control.—International Business Corp., 590 Madison Ave., New York 22, N. Y.

Circle **570** on inquiry card.

Computing Equipment. New 4-page folder "GEDA Penetrates the Unknown", describes research services and equipment, including analog-computing equipment, available to government and industry at Armour Research Foundation of Illinois Institute of Technology.—Goodyear Aircraft Corp., Akron 15, Ohio.

Circle **571** on inquiry card.

Tape Readers. New 2-page bulletin describes and illustrates maker's paper-tape readers "Models FR-350 and DR-310" for reading perforated tapes at rates up to 60 characters per second.—Soroban Engineering, Inc., Box 117, Melbourne, Fla.

Circle **572** on inquiry card.

Digital Converters. New 12-page Bulletin 58-10 describes and illustrates maker's "Digi-Coder" digital converters, including electro-mechanical, shaft-position and voltage types.—Fischer & Porter Co., 302 Jacksonville Rd., Hatboro, Pa.

Circle **573** on inquiry card.

FORCE, STRESS

Load Transducers. New 2-page bulletin describes maker's load transducers "Series 140 and 141" for electrical transmission of force, weight or stress with high accuracy.—Daytronic Corp., 216 S. Main St., Dayton, Ohio.

Circle **574** on inquiry card.

Dynamometer. Four new 2-page bulletins describe maker's "R1040-1" wheel-force dynamometer for measuring forces applied to aileron and elevator controls; "R1040-2" stick-force dynamometer used for measuring aileron and elevator control forces; "R1040-3" rudder-force pedal dynamometers; and "R1040-6" servometer.—Radiation, Inc., 501 Commonwealth Ave., Orlando, Fla.

Circle **575** on inquiry card.

Stress Analysis. New 4-page Leaflet 17 describes maker's polaroid photoelastic demonstration apparatus for visual presentation of stress.—Ann Arbor Instrument Works, 725 Packard St., Ann Arbor, Mich.

Circle **576** on inquiry card.

SPEED, TIMING

Tachometer. New 4-page bulletin describes maker's "Visutac" spring-wound "Stroboscopic" hand tachometer for measuring rotary and vibratory speeds.—Boulin Instrument Corp., 65 Madison Ave., New York 16, N. Y.

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Timing Instrument. New 8-page issue of "Hobbs Hour Meter Talks" (Vol. 7, No. 2) presents articles on Hobbs engine-hour meters giving hours and minutes of engine operation.—John W. Hobbs Corp., Springfield, Ill.

Circle **578** on inquiry card.

ACCELERATION, MOTION

Accelerometers. Two new 2-page Bulletins (ELA1, 2) presents specifications on maker's miniature, high-temperature accelerometers.—Pacific Scientific Co., 1430 Grande Vista Ave., Los Angeles 23, Calif.

Circle **579** on inquiry card.

Motion Analyzer. New 4-page bulletin describes maker's "Vanguard" motion analyzer, a specialized projector for measuring linear motion vs. time interval of events recorded on film and for determining velocities, accelerations, deflections and stresses.—Photographic Analysis Co., 100 Rock Hill Rd., Clifton, N. J.

Circle **580** on inquiry card.

COUNT

Electronic Totalizer. New 2-page Specification Sheet L-2 describes and illustrates maker's electronic totalizer for counting pulse or sine-wave signals of 10 millivolts at frequencies up to 1000 cps.—Potter Aeronautical Co., U. S. Route 22, Union, N. J.

Circle **581** on inquiry card.

Blood Arithmometer. New 4-page Brochure A-12-54 describes and illustrates maker's blood "Arithmometer," a blood-counting device for lab work in diagnosing value of both white and red cell blood counts.—Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.

Circle **582** on inquiry card.

GAGING

Ultrasonic Thickness Gaging. New 6-page Bulletin A2 describes maker's "Audigage" thickness testers for measuring thickness of metals, glass, rigid plastics, etc. by ultrasonics.—Branson Instruments, Inc., 430 Fairfield Ave., Stamford, Conn.

Circle **583** on inquiry card.

Extensometer Strain Gages. New 8-page Bulletin 21 describes and illustrates maker's strain gages for determining distortion of structures, machine parts, bending, etc.—Ann Arbor Instrument Works, 725 Packard St., Ann Arbor, Mich.

Circle **584** on inquiry card.

Comparator. New 2-page bulletin describes maker's "Millimess" amplifying comparator that is graduated in 0.00005 in., and used for checking outside and inside measurements, thickness, out-of-round conditions, taper, ovalness, threads and gears.—George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

Circle **585** on inquiry card.

Ball Wavometer. New 8-page Leaflet B1 describes maker's ball wavometer inspection instrument for measuring waviness of balls from 1/16 to 1¼ inch diameter.—Micrometrical Development Corp., Ann Arbor, Mich.

Circle **586** on inquiry card.

Thread Triangles. New 4-page leaflet presents description of maker's thread triangles which are hardened, precision-ground gages in form of two 60-degree triangular bars.—Montgomery & Co., Inc., 53-B Park Place, New York 7, N. Y.

Circle **587** on inquiry card.

Dial Indicator Gages. New 8-page leaflet pictures and describes maker's dial indicators "Models 222, 225, 333, 334 and 335."—Gem Instrument Mfg. Co., Cleveland 3, Ohio.

Circle **588** on inquiry card.

Gage. New 6-page Bulletin UMG-55 describes and illustrates maker's precision undercut measurement gage for measuring "O" ring grooves, tapers, recesses, etc.—Mueller Laboratory, 239 W. Maple Ave., Monrovia, Calif.

Circle **589** on inquiry card.

Angle Comparator. New 8-page illustrated Brochure FD-53 describes maker's angle comparator for quality control in machine shops and metal working departments.—Perkin-Elmer Corp., Norwalk, Conn.

Circle **590** on inquiry card.

TESTING

Ultrasonic Testing. New 8-page Bulletin 50-105 presents maker's "Reflectoscope" for testing a variety of metals and materials for surface and internal defects by ultrasonics.—Sperry Products, Inc., Shelter Rock Rd., Danbury, Conn.

Circle **591** on inquiry card.

Hardness Tester. New set of bulletins describe and illustrate maker's bench adapter used with portable metal-hardness tester to give direct dial readings. Includes 2-page price list.—Newage International, Inc., 235 E. 42nd St., N. Y. 17, N. Y.

Circle **592** on inquiry card.

Surface Tension Tester. New 2-page Bulletin 2 describes maker's "Jiffy-Loop" surface tension tester for surface tensions of solutions up to 200 F.—Pollack Products Co., 1628 E. 7th St., Brooklyn 30, N. Y.

Circle **593** on inquiry card.

Indention Tester. New 4-page booklet describes maker's "Durometer" rubber indention tester and "Z 224" control instrument which permits constant control of "Durometer" accuracy before and after each test.—William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.

Circle **594** on inquiry card.

Grease Tester. New 2-page Data Sheet 11498 describes maker's redesigned water-washout grease tester for evaluating resistance of lubricating greases in a rotating bearing to washout by water.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

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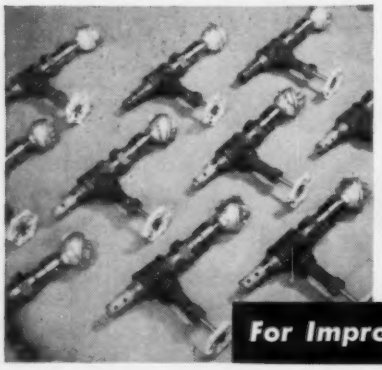

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TEST CHAMBERS

Test Chambers. New 2-page bulletin presents specifications on maker's salt-spray fog test chambers.—Development Engineering Co., 9 Cross St., Norwalk, Conn.

Circle **596** on inquiry card.

Temperature Cabinets. New 4-page Bulletin 101 describes and illustrates maker's temperature cabinets "Models TAS-12-120A, TAS-2-120A, and TAU-27-100WH."—Trop-Arctic Temperature Products, 627 S. Mulberry St., Muncie, Ind.

Circle **597** on inquiry card.

RADIOACTIVITY

Industrial Research Nuclear Reactor. New 14-page Booklet DM-1271 presents "Proposal for an Industrial Research Reactor Facility—owned and operated by Industry."—American Machine & Foundry Co., AMF Building, 261 Madison Ave., New York 16, N. Y.

Circle **598** on inquiry card.

Radioactivity Consultants. New 24-page brochure describes services that can expedite development of nuclear power and industrial applications of radioactivity techniques. Services include research, development, technical services, consultation, equipment procurement, and industrial surveys.—Nuclear Science & Engineering Corp., P. O. Box 10901, Pittsburgh, Pa.

Circle **599** on inquiry card.

Radiation Instruments. New 28-page Catalog B describes and illustrates maker's scintillation counters, scalers, circuits, and radioactivity counting accessories.—NRD Instrument Co., 6425 Etzel Ave., St. Louis, Mo.

Circle **600** on inquiry card.

Strip Scanner. New 2-page bulletin describes maker's "Model 2001" paper strip scanner for photometric or radioactivity readings of paper strips.—Research Specialties Co., 1148 Walnut St., Berkeley 7, Calif.

Circle **601** on inquiry card.

AIRCRAFT, GYROS

Range Servos. New 32-page bulletin "An Introduction to the "A" Series Range Servo" describes pictorially the components, principles, and operation of maker's range servos for radar-controlled gunfire-control systems.—Servomechanisms, Inc., 500 Franklin Ave., Garden City, N. Y.

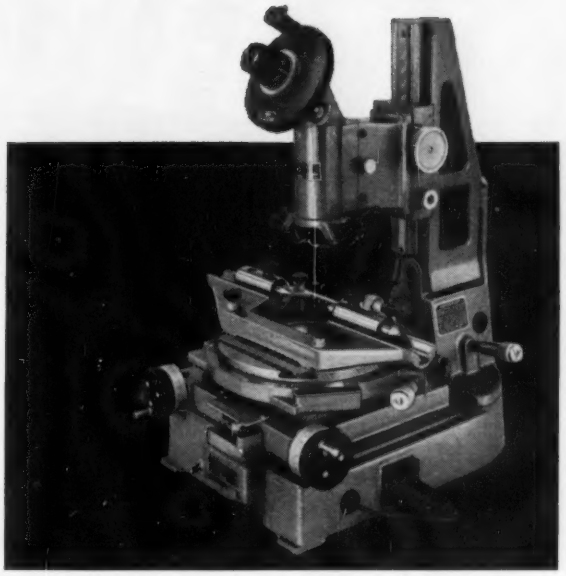
Circle **602** on inquiry card.

Aircraft Instruments. New 4-page Bulletin LP 3509 describes maker's simulator instruments designed to provide indications which duplicate those of a corresponding airborne aircraft instrument.—Link Aviation, Inc., Binghamton, N. Y.

Circle **603** on inquiry card.

Answers to I.Q. Quiz on page 468

1.—c	4.—a	7.—a
2.—d	5.—b	8.—d
3.—c	6.—c	9.—b



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Gyros. Seven new 2-page brochures (EFG-1,2, ERG-1-3, and EVG 1, 2) present maker's vertical, rate, free, and miniature gyros.—Pacific Scientific Co., Los Angeles 23, Calif.

Circle **604** on inquiry card.

OPTICS

Photo Equipment. New 96-page 55th Anniversary Catalog 154-K describes and illustrates maker's complete line of photo equipment. Includes adapters, battery tester, binoculars, bulbs, cameras, development equipment, exposure meters, flood bulbs, film hangers, lenses, microscope adapter, negative preservers, etc.—Burke & James, Inc., 321 S. Wabash Ave., Chicago 4, Ill.

Circle **605** on inquiry card.

Miniature Photocopier. New 4-page leaflet describes maker's "Diafix 35" photo-lab instrument which copies miniature photograph strips on perforated paper and positive film.—Burke & James, Inc., 321 S. Wabash Ave., Chicago, Ill.

Circle **606** on inquiry card.

Light-Scattering Photometer. New 20-page Bulletin BP-1000 describes 1000 Series" light-scattering photometer and illustrates maker's "Universal meter for measuring of micro-scattering, micro-fluorescence, micro-lumines

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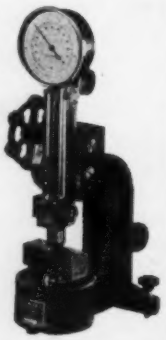

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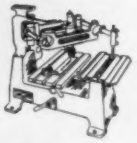

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NEW LITERATURE

cence, and very low transmittance and reflectance of dark materials.—Phoenix Precision Instrument Co., 3803-05 N. Fifth St., Philadelphia 40, Pa.

Circle **607** on inquiry card.

Laminated Color Filter. New 2-page bulletin describes maker's "Microlam" precision-thin lamination process of laminating color and polarized sheets which can be cut, edged, drilled and polished.—Marks Polarized Corp., Whitestone, L. I., N. Y.

Circle **608** on inquiry card.

Microscope Illuminator. New 6-page Bulletin 1000-454 describes and illustrates makers "Ortho-Illuminator B" that features efficient illumination, instant adaptability to widely differing operational requirements, etc.—Silge & Kuhne, 16th & Carolina Sts., San Francisco 19, Calif.

Circle **609** on inquiry card.

Industrial Periscopes. New 4-page Bulletin 301 describes maker's industrial periscopes for special assignments in remote viewing.—Kollmorgen Optical Corp., 30 Church St., New York 7, N. Y.

Circle **610** on inquiry card.

ITV. New 4-page Bulletin E.51 presents application and construction details of maker's "ITV-6" closed-circuit television.—Radio Corporation of America, Engineering Products Div., Camden 2, N. J.

Circle **611** on inquiry card.

LAB APPARATUS

Lab Equipment. New 24-page Booklet 80 contains information and photographs on scientific instruments, apparatus and lab supplies.—Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.

Circle **612** on inquiry card.

Laboratory Pen. New illustrated card describes maker's "Tech-Pen" which writes with clear, brilliant, opaque, permanent ink on glass, metal, porcelain, paper, plastic, cloth, and leather.—Palo Laboratory Supplies, Inc., 81 Reade St., New York 7, N. Y.

Circle **613** on inquiry card.

Lab Equipment. New 20-page issue of "Burrell Announcer" (No. 55-1-57) describes maker's automatic burrettes, lab shakers, metallurgical microscope, variable transformer, immersion pump, etc.—Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Circle **614** on inquiry card.

Lab Apparatus. New 12-page issue of "Lanco Apparatus Review" (No. 5) describes and illustrates maker's line of laboratory apparatus which include atom models, balances, glass beads, electrothermal tapes, heating mantles, polyethylene labware, etc.—Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

Circle **615** on inquiry card.

Laboratory Stirrer. New 2-page Bulletin 440 describes and illustrates maker's hollow-spindle "Lab-Stir" for light-duty laboratory stirring.—Eberbach Corp., Ann Arbor, Mich.

Circle **616** on inquiry card.

Pipette Washer. New 2-page bulletin describes maker's "Model 6312" automatic pipette washer for cleaning sampling tubes or pipettes.—National Appliance Co., 1238 S. E. Union Ave., Portland 14, Ore.

Circle **617** on inquiry card.

Incubators. Two new 2-page bulletins describe maker's "Elconap Type A" anhydric electric incubators; and "Type B" electric-controlled constant-temperature anhydric research incubators and paraffin embedding ovens. —Electric Heat Control Apparatus Co., 507 Fifth Ave., N. Y. 17, N. Y.

Circle **618** on inquiry card.

Volumetric Analysis. New 16-page Bulletin FS-247 describes and illustrates maker's electrometric titrators for volumetric analysis of chemical control.—Fisher Scientific, 717 Forbes St., Pittsburgh 19, Pa.

Circle **619** on inquiry card.

Distillation. New 4-page Bulletin 2661385 "Engelhard Industries Newsletter" features article on maker's "Bi-Distillation Unit" which automatically performs distillation and redistillation in one operation.—Engelhard Industries, 113 Astor St., Newark 5, N. J.

Circle **620** on inquiry card.

Lab Equipment. New 6-page Bulletin 22M describes and illustrates "Servall" angle centrifuge rotors, "LKB" paper electrophoresis, "Sjostrand" ultra-microtome for electron microscopy, interval timers, etc.—Ivan Sorvall, Inc., Norwalk, Conn.

Circle **621** on inquiry card.

ANALYTICAL

Conductivity Analyzer. New 4-page Bulletin 11-70 presents description on maker's continuous electro conductivity analyzer for analysis of gases and vapors.—Davis Instruments, 47 Halleck St., Newark 4, N. J.

Circle **622** on inquiry card.

Viscometer. New 8-page leaflet describes and illustrates maker's viscometer for measuring fluid viscosity.—Drage Products, 406 32nd St., Union City, New Jersey.

Circle **623** on inquiry card.

Spectrophotometer Recorder. New 20-page Bulletin FS-245 describes and illustrates maker's "Spectracord" recorder which automatically records complete analytical data on a sample within 1.5 min.—Fisher Scientific Co., 717 Forbes St., Pgh. 19, Pa.

Circle **624** on inquiry card.

Infrared Filter. New 2-page Bulletin RD-512 describes maker's germanium infrared transmission filter used in conjunction with lead-sulfide infrared photo detectors. 2-page bulletin presents maker's "Spectromet" spectrochemical analyzer.—Baird Associates, Inc., 33 University Rd., Cambridge 38, Mass.

Circle **625** on inquiry card.

X-ray Analysis. New 4-page issue of "Spectrographer's Newsletter" (Vol. 7, No. 3) features article on "X-ray Analysis of Metallic Elements in Nonmetallic Material."—Applied Research Laboratories, P.O. Box 1710, Glendale 5, Calif.

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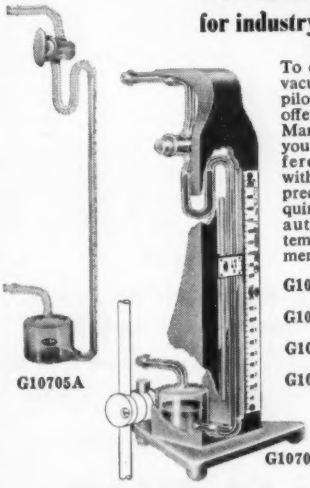

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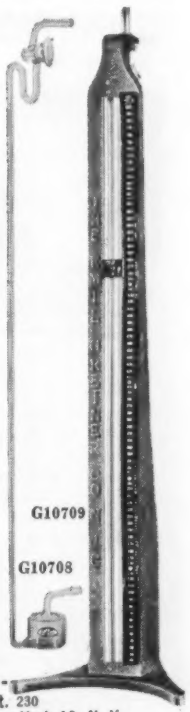

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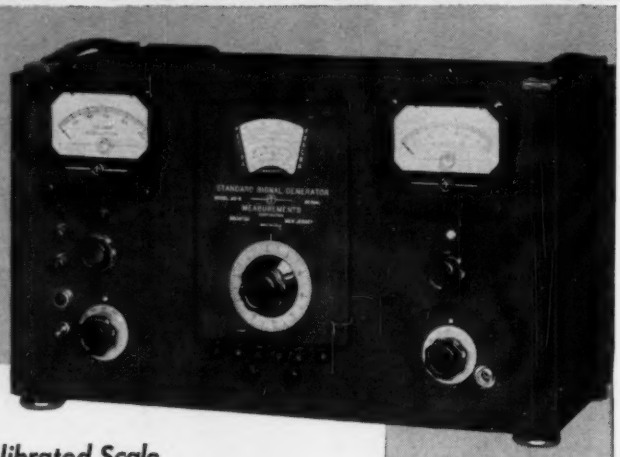

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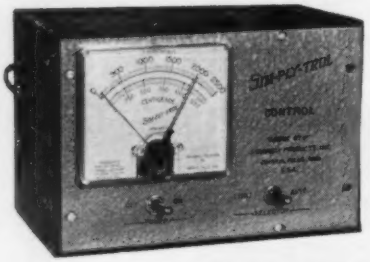

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Thermocouple type Automatic Pyrometer for controlling temperature in furnaces, ovens, and processes. The Simplytrol is economical and reliable with few moving parts. There are no vacuum tubes. The regular load relay is S.P.D.T. 5 Amps. Optional heavy duty relays to 40 Amps.

10 temperature ranges cover from −75° to 3000° F. Several special ranges to −400° F. "On & Off" control for holding the desired temperature works on gas, oil or electric heat. Indicating meter-relay is medium high resistance and has bimetal cold junction compensation. For use with all standard thermocouples. Accuracy 2%.

"Auto-Limit" switch changes Simplytrol from automatic controller to limit pyrometer for safety shut down or warning. Cabinet: 6½x 6½x9½ inches. Also flush panel mount models. Send for new Bulletin G-7 for more data.
Assembly Products, Inc., Chesterland 10, Ohio.
Booth 311, I.R.E. Show, March 21-24

For more information circle **147** on inquiry card.

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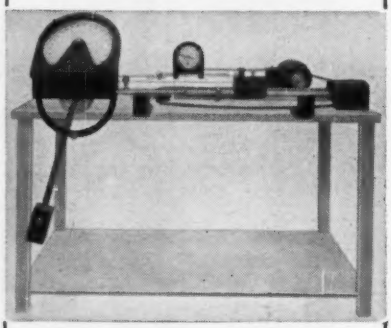
TENSILE STRENGTH

TESTERS



type 274

for VERY LIGHT MATERIALS

Horizontal type—Bench Model

Various ranges up to maximum of 25 lbs.
With or without elongation indicator.

Write for bulletin 129

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TESTING INSTRUMENT CO., INC.
48 Van Sinderen Ave., Brooklyn, N. Y.

For more information circle **148** on inquiry card.

NEW LITERATURE

R-F INSTRUMENTS

Field Intensity Meter. New 4-page bulletin describes and illustrates maker's "NM-30A" radio interference and field intensity meter for interference location and measurement.—Stoddard Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.
Circle **627** on inquiry card.

Microwave Amplifiers. New 6-page "Hewlett-Packard Journal" (Vol. 6, No. 3-4) features article on "New Broadband Microwave Power Amplifiers Using Helix-Coupled TWT'S."—Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.
Circle **628** on inquiry card.

Waveguide Attenuator. New 4-page issue of "Hewlett-Packard Journal" (Vol. 6, No. 5) features article on "A Precision Wave Guide Attenuator Which Obeys a Mathematical Law."—Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.
Circle **629** on inquiry card.

Microwave Equipment. New 8-page Catalog 112 describes maker's direct-reading automatic VSWR meters, microwave and special x-band components, microwave peakpower test set, phase meter, Klystron power supply, and standing wave amplifier.—Cubic Corp., 2841 Canon St., San Diego, Calif.
Circle **630** on inquiry card.

Radio Interference Filters. New 22-page Catalog FSR presents maker's complete line of "Type FSR RF" interference-suppresion filters for use in screen rooms, induction-heating equipment, diathermy, X-ray units, etc.—Filtron Co., Inc., Flushing, L. I., N. Y.
Circle **631** on inquiry card.

A-F EQUIPMENT

Hi-Fi Systems. New 160-page 1955 Audio Reference Guide covers latest models of leading high-fidelity component manufacturers including specifications, pictures, and dealers net prices.—Leonard Radio, Inc., 69 Cortland St., New York City 7, N. Y.
Circle **632** on inquiry card.

ELECTRONIC INSTRUMENTS

Digital Voltmeters. New 4-page Bulletin 30 describes maker's digitized-readout voltmeter that measures d-c voltages and can automatically operate printers, electric typewriters and IBM punches. Bulletin 20 describes digital in-line read-outs for application in systems requiring visual digital indication.—Electro-Instruments, P.O. Box S, Old San Diego Station, San Diego 10, Calif.
Circle **633** on inquiry card.

Etched Circuitry. New 2-page bulletin presents description and characteristics of maker's packaged, etched circuitry.—Audio Products Corp., 2265 Westwood Blvd., Los Angeles 64, Calif.
Circle **634** on inquiry card.

Oscilloscopes. New 14-page bulletin presents description on maker's "Type

530" cathode-ray oscilloscopes for general purpose laboratory use.—Tektronix, Inc., P. O. Box 831, Portland 7, Oregon.

Circle **635** on inquiry card.

Oscilloscopes, Monitors. New 4-page leaflet presents maker's line of portable and panel-mount oscilloscopes and waveform monitors.—Probescope Co., 44-05 30th Ave., Long Island City 3, N. Y.

Circle **636** on inquiry card.

Phase Meter. New 4-page Bulletin 950 describes maker's "Model P-1060" precision phase meter for precise measurement of phase difference at audio frequencies.—W. L. Maxson Corp., 460 W. 34th St., New York 1, N. Y.

Circle **637** on inquiry card.

Harness Tester. New 2-page bulletin describes and illustrates maker's automatic continuity tester which checks a 100-wire cable harness in 12 seconds.—Electronic Control Systems, Inc., 2138 Westwood Blvd., Los Angeles 25, Calif.

Circle **638** on inquiry card.

Deviation Bridge. New 2-page Bulletin 38B describes maker's deviation bridge-resistance comparator for rapid inspection and testing. Bulletin 32B describes maker's sorting bridge high-speed automatic instrument for determining value of a resistor.—Barnes Development Co., 213 W. Baltimore Pike, Lansdowne, Pa.

Circle **639** on inquiry card.

Network Calculations. New 4-page Nomograph 1.1 discusses "Elegant versus Elaborate Network Calculations," pertaining both to steady state and transient conditions. Price 20c.—Stockman Electronics Research Co., 543 Lexington St., Waltham 54, Mass.

Circle **640** on inquiry card.

PANEL INDICATORS

Panel Indicators. New 8-page issue of "Electrical Measurements" (Vol. 21, No. 10) features article "We Don't Agree That Panel Instruments Cannot Be Made More Accurate Than 1 or 2 Percent."—Sensitive Research Instrument Corp., Mount Vernon, N. Y.

Circle **641** on inquiry card.

Panel Indicators. Two new 2-page bulletins describe maker's "Model 150" sealed, round panel-instrument for one-hole mounting; and "Model 152" sealed, square panel-instrument for front or rear panel mounting.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **642** on inquiry card.

Panel Indicators. New 2-page Data Sheet 163 describes maker's "Model 163" miniature panel meter that meets MIL-M 10304 (SIG.C) specifications.—International Instruments, Inc., P. O. Box 2954, New Haven 15, Conn.

Circle **643** on inquiry card.

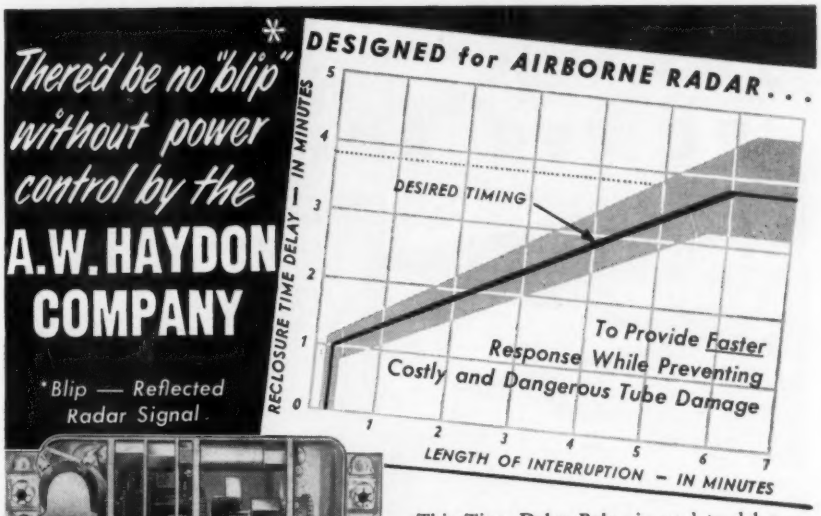
POWER SUPPLIES

Power Packs. New 2-page bulletin describes maker's "Transpac" miniaturized power packs for transistors, vacuum tubes, and standard applications.—Electronic Research Associates, Inc., Box 29, Caldwell, N. J.

Circle **644** on inquiry card.

There'd be no "blip"* without power control by the A.W. HAYDON COMPANY

*Blip — Reflected Radar Signal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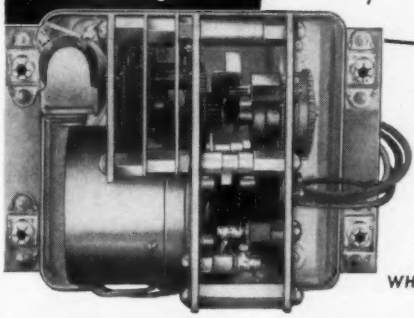

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Model MR 2432-100X 24 to 32 volts @ 100 amps

SPECIFICATIONS

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AC INPUT: 230 or 460V. ±10%, 3 phase, 60 cycles

RESPONSE TIME: 0.2 seconds

RIPPLE: 1% rms. WEIGHT: 250 lbs.

VOLTAGE REGULATION: ±½%: (a) from no load to full load; (b) from

DIMENSION: 25" long x 15" deep x 15" high

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For more information circle **151** on inquiry card.

DC Supply. New 2-page Bulletin 102 presents specifications on maker's "Model EM4-28-1B" tubeless magnetic-amplifier d-c supply for operating strain gages.—Engineering Magnetics, 11812 Teale St., Culver City, Calif.

Circle **645** on inquiry card.

SWITCHES, RELAYS

Subminiature Switches. New 12-page Catalog 75 describes and illustrates maker's snap-action precision and subminiature switches, auxiliary actuators, toggle and push-button subminiature switch assemblies.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **646** on inquiry card.

Mercury Plunger Relays. New 2-page bulletin presents features and ratings of maker's mercury plunger relays.—Philadelphia Scientific Glass Co., 4 Eckard Ave., Abington, Pa.

Circle **647** on inquiry card.

Neomatic Relays. New 8-page issue of "Newsletter" features article on maker's neomatic relays used in Convair F-102 Jet Interceptor.—Elgin-Neomatic, Inc., 9010 Bellanca Ave., Los Angeles 45, Calif.

Circle **648** on inquiry card.

Control Switch. New 4-page bulletin describes maker's flash-heating control-switch used in appliances. Includes specifications.—Proctor Electric Co., 3rd St. and Hunting Park Ave., Phila. 40, Pa.

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Wilmington 98, Delaware

Rotary Limit Switch. New 4-page bulletin describes maker's rotary limit switch for presses, loaders, valves, etc.—Gemco Electric Co., 25681 W. 8 Mile Rd., Detroit 19, Mich.

Circle **650** on inquiry card.

POTENTIOMETERS

Potentiometers. New 8-page issue of "Experimenter, Jan., 1955" (Vol. 29, No. 8) features article on "The New 970-Series Potentiometers—High-Quality Performance At Moderate Prices."—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **651** on inquiry card.

Circular Rectilinear Potentiometers. New set of five 2- and 4-page brochures (ECP-1, 2; ERP-1, 2, 3) present maker's circular (for angular movement) and rectilinear (linear motion) precision potentiometers.—Pacific Scientific Co., Los Angeles 23, Calif.

Circle **652** on inquiry card.

Potentiometer Linearities. New 4-page graphically-illustrated Bulletin 753813010 presents definitions and comparisons of linearities as a practical guide to users of potentiometers.—Clarostat Mfg. Co., Inc., Dover, New Hampshire.

Circle **653** on inquiry card.

Potentiometers. Three new 4-page bulletins present description and illustrations of maker's multiple turn, single turn and rectilinear potentiometers.—General Scientific Corp., 12017 Vose St., N. Hollywood, Calif.

Circle **654** on inquiry card.

Potentiometers. New 2-page Bulletin D54-1 describes maker's "Types 2234 and 2235" rectilinear-motion potentiometers. Bulletin D54-A describes maker's "Types 2134 and 2135" rectilinear potentiometers with integral trimming resistors.—Markite Corp., 155 Waverly Place, New York 14, N. Y.

Circle **655** on inquiry card.

MAGNETS

Permanent Magnets. New 12-page issue of "Applied Magnetics" (Vol. 3, No. 1) features article on "How To Magnetize Permanent Magnets."—Indiana Steel Products Co., 405 Elm St., Valparaiso, Indiana.

Circle **656** on inquiry card.

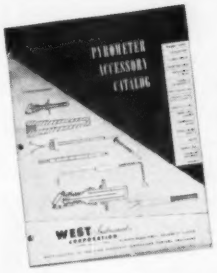
ELECTRONIC COMPONENTS

Magnet Wire Handbook. New 118-page Catalog C-79 pictures and describes maker's round, square and rectangular magnet wire. Includes charts giving resistance and weight of bare copper wire; also psychrometric tables, a-c formulae, conductivity tables, temp.-coeff. tables, temp. conversion tables, trigonometric formulae, etc.—Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.

Circle **657** on inquiry card.

Junction Transistor. New 2-page Bulletin ECG-58 presents specifications of maker's "Type 2N76" germanium, fused-junction transistor triode for intermediate-gain, low-power

THERMOCOUPLES
for every industry



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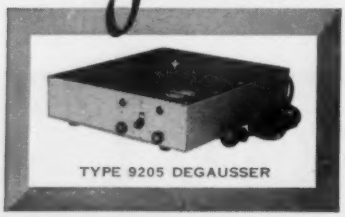

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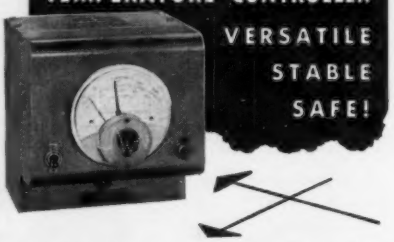

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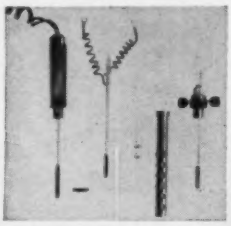

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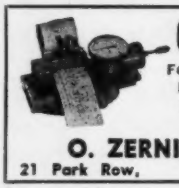

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For more information circle **161** on inquiry card.

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NEW LITERATURE

applications.—General Electric Co., Electronics Park, Syracuse, N. Y.
Circle **658** on inquiry card.

Tubes. New 6-page Bulletin 20/C/-4876-A presents characteristics and operating conditions of maker's 10,000-hr. tubes for all electronic applications.—Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.
Circle **659** on inquiry card.

Transformers. New 20-page catalog describes and illustrates maker's custom-specified transformers.—General Transformer Co., 18240 Harwood Ave., Homewood, Ill.
Circle **660** on inquiry card.

Rack, Panel Connectors. New 64-page Engineering Bulletin DP9 describes maker's plug-in connectors for rack panel-chassis applications, aircraft, computers, etc.—Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.
Circle **661** on inquiry card.

Autotransformer. New 16-page Bulletin 424-N presents specifications and illustrations on maker's continuously-adjustable Variac autotransformers, assemblies and special-purpose terminal boxes.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Circle **662** on inquiry card.

Pilot Lights. New set of Bulletins L-151, L-155, L-156 and L-157 picture and describe maker's pilot lights designed to meet requirements for indication, automation and miniaturization.—Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.
Circle **663** on inquiry card.

Lamp Sockets. New 24-page Booklet 540 describes and illustrates maker's double-contact bayonet and candelabra screw sockets, mniature screw and bayonet sockets, etc.—Leecraft Manufacturing Co., Inc., 60 Greene St., New York 12, N. Y.
Circle **664** on inquiry card.

Fluorescent Lamps. New 4-page Bulletin SE 115419 presents information for installation and operation of maker's rapid-start fluorescent lamps. Includes wiring diagram and explains type of ballasts, sockets and switches to be used.—Superior Electric Co., 83 Laurel St., Bristol, Conn.
Circle **665** on inquiry card.

Electrical Insulators. New 12-page Bulletin 546 pictures and describes maker's "AlSiMag L-5" high-frequency electrical insulators that meet military specifications.—American Lava Corp., Cherokee Blvd. & Mfgrs. Rd., Chattanooga 5, Tenn.
Circle **666** on inquiry card.

Insulated Clips. New 2-page Data Sheet 168 describes and illustrates maker's vinyl-insulated alligator clips used on wires, terminals, tabs, studs, etc.—Mueller Electric Co., 1574-L E. 31 St., Cleveland 14, Ohio.
Circle **667** on inquiry card.

Continued on page 487.

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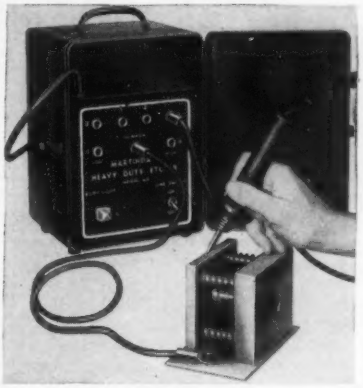

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Multi-Tube Manometers

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NEW LITERATURE

MECHANICAL COMPONENTS

Miniature Bearings. New 4-page issue of "Engineering News" (Vol. 1, No. 2) features article on "MPB Bearings Convert Rotary To Linear Motion."—Miniature Precision Bearings, Inc., Keene, N. H.

Circle **668** on inquiry card.

Socket Screws. New 20-page Bulletin 899 describes maker's multiple-spline socket screws for use in machinery that operate with high shock and vibration.—Bristol Co., Bristol Road, Waterbury 20, Conn.

Circle **669** on inquiry card.

Socket Screws. New 20-page Bulletin 898 describes and illustrates maker's hex socket flat head cap screws, pipe plugs, shoulder screws or stripper bolts, and screw keys.—Bristol Co., Bristol Rd., Waterbury 20, Conn.

Circle **670** on inquiry card.

Beryllium Copper Springs. New 16-page Catalog 9 presents description of maker's micro-processed beryllium copper springs, including compression, flat and strip springs; contact strips and contact rings.—Instrument Specialties Co., Inc., Little Falls, N. J.

Circle **671** on inquiry card.

Micro Springs. New 16-page Catalog 8 describes and illustrates maker's micro-processed beryllium-copper brush springs for ac and dc motors, and switches.—Instrument Specialties Co., Inc., Little Falls, N. J.

Circle **672** on inquiry card.

Rubber Isolators. New 2-page illustrated Bulletin 543 describes and illustrates maker's "Barrymounts Series 275, 302, 371 and 372" molded natural-rubber isolators for protecting sensitive instruments, tubes, etc.—Barry Corp., 700 Pleasant St., Watertown 72, Mass.

Circle **673** on inquiry card.

Knobs, Handles. New 12-page booklet presents description of maker's thermosetting plastic standard knobs and handles. Includes instrument, pointer, bar, radio, and control knobs.—Kurz-Kasch, Inc., Dayton 1, Ohio.

Circle **674** on inquiry card.

ELECTROMECHANICAL

Slip Rings. New 6-page folder describes and illustrates maker's subminiature slip rings and brush holder assemblies for gyroscope applications.—Electro Development Co., 14701 Keswick St., Van Nuys, Calif.

Circle **675** on inquiry card.

Magnetic Clutches. New 4-page leaflet presents specifications and dimensional data on maker's magnetic clutches.—Dial Products Co., 55 Evergreen Ave., Newark 5, N. J.

Circle **676** on inquiry card.

TUBING, SUPPORTS

Tubing. New 8-page Bulletin 40 describes and illustrates types of maker's tubing including stainless steel, nickel and nickel alloys, carbon and alloy steels, beryllium copper and titanium.—Superior Tube Co., 1564 Germantown Pike, Norristown, Pa.

Circle **677** on inquiry card.

Titanium Tubing. New 8-page Bulletin 43 presents description of maker's unalloyed-titanium tubing for refrigeration, hydraulic and pneumatic lines, and low-stress structural applications—Superior Tube Co., 1564 Germantown Pike, Norristown, Pa.

Circle **678** on inquiry card.

Pipe Adapters. Two new 2-page Data Sheets 4401A10 and 4401A11 describe maker's male pipe adapters for "hoze-lok" swivel-nut fittings, and "SFG" swivel male pipe connector for

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NEW LITERATURE

"Hose-lok" male pipe thread fitting.—Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

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Tube Burring Tool. New 2-page Data Sheet 1149 A1 pictures and describes maker's "IN-EX" burring tool used for internal and external burring of tubes. Handles copper, brass, aluminum alloy or annealed steel tubing.—Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **680** on inquiry card.

Flareless Tube Ends. New 2-page Bulletin 4320A11 illustrates maker's "Ferulok HHBU" long-union flareless tube end—both ports. Bulletin 4310A14 illustrates "Triple-lok HHBTX" long-union flare tube end—both ports.—Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **681** on inquiry card.

Instrument Tubing Support. New 8-page Bulletin 1254-D presents maker's "Tubetrof" for solving problems of design, fabrication, and installation for support of instrument tubing.—P-W Industries, Inc., 4500 Melrose Sts., Phila. 24, Pa.

Circle **682** on inquiry card.

Cable Supporting System. New 8-page Bulletin 754-A describes and illustrates maker's system for supporting cable including: straight trough, trough covers, connectors, fittings, etc.—P-W Industries, Inc., 4500 Melrose St., Phila. 24, Pa.

Circle **683** on inquiry card.

Metal Hose. New 4-page Booklet IND-3 describes and illustrates maker's seamless flexible bronze hose for conveying steam, gases, liquids and fine solids to temperature of 450 F.—Packless Metal Hose, Inc., 31 Winthrop Ave., New Rochelle, N. Y.

Circle **624** on inquiry card.

Plastic Tubing. New 4-page booklet describes maker's "Armourvin" a chemically inert translucent-plastic tubing for carrying gasoline and other highly volatile fluids.—Newage International, Inc., 235 E. 42nd St., New York 17, N. Y.

Circle **685** on inquiry card.

Tubing. New 4-page leaflet describes and illustrates maker's copper, brass and aluminum tubing in various shapes and sizes.—Fromson Orban Co., Inc., 261 Madison Ave., New York 16, N. Y.

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AIR

Air Dehydrator. New 2-page Bulletin C-5154 presents specifications on maker's "Models CM-1, CM-15-3 and CM-25-6" compressed-air dehydrafilters.—Hankison Corp., 951 Banksville Rd., Pittsburgh 16, Pa.

Circle **687** on inquiry card.

SHOP EQUIPMENT

Cabinets, Shop Equipment. New 16-page catalog presents illustrations on maker's "See-Thru" drawer cabinets, portable wireless intercom, stock carts, etc.—General Industrial Co., 5737 N. Elston, Chicago 30, Ill.

Circle **688** on inquiry card.

Hand Engraving. New 4-page Brochure R-954-5M illustrates and describes maker's hand engraving machines for engraving sunken lettering in metal products, jewelry, etc.—H. P. Preis Engraving Machine Co., 651 U. S. Highway 22, Hillside, N. Y.

Circle **689** on inquiry card.

Tapping Machine. New 4-page bulletin describes maker's multi-spindle adjustable drilling, boring and tapping machine which machines with one stroke as many as 100 holes of any pattern with repetitive accuracy.—Gangdriller Machine Works, Inc., 340 Ten Eyck St., Brooklyn 6, N. Y.

Circle **690** on inquiry card.

FABRICATION

Metal Fabrication. New 16-page Catalog 550 presents maker's amplifier foundations, bottom plates, speaker boxes, brackets, cabinets, panels, relay racks, sliding drawer assemblies, etc.—Premier Metal Products Co., 3160 Webster Ave., New York 67, N. Y.

Circle **691** on inquiry card.

Instrument Manufacturing. New 16-page brochure presents description of facilities available for subcontract manufacturing of precision instruments, and describes supporting services such as field service and technical publications.—Avien, Inc., 58-15 Northern Blvd., Woodside 77, N. Y.

Circle **692** on inquiry card.

Electrical, Mechanical Fabrication. New 4-page Bulletin DS-133 describes and illustrates maker's specialized development services and facilities for production of battery chargers, electronic control assembly, control switch, tapped reactor, thermal cutout, solenoid coil, etc.—Curtis Development & Mfg. Co., 3266 N. 33rd St., Milwaukee 16, Wis.

Circle **693** on inquiry card.

MATERIALS

Insulating Materials. New 32-page Catalog 17 describes, illustrates, gives prices and ordering data on maker's electrical insulating materials—tapes, varnishes, solvents, etc.—Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.

Circle **694** on inquiry card.

Insulating Rosin Flux. New 4-page Brochure 3274 presents maker's line of fluxes, rosin-core solder, fluxcote and flux removers.—London Chemical Co., Inc., 325 W. 32nd St., Chicago 16, Ill.

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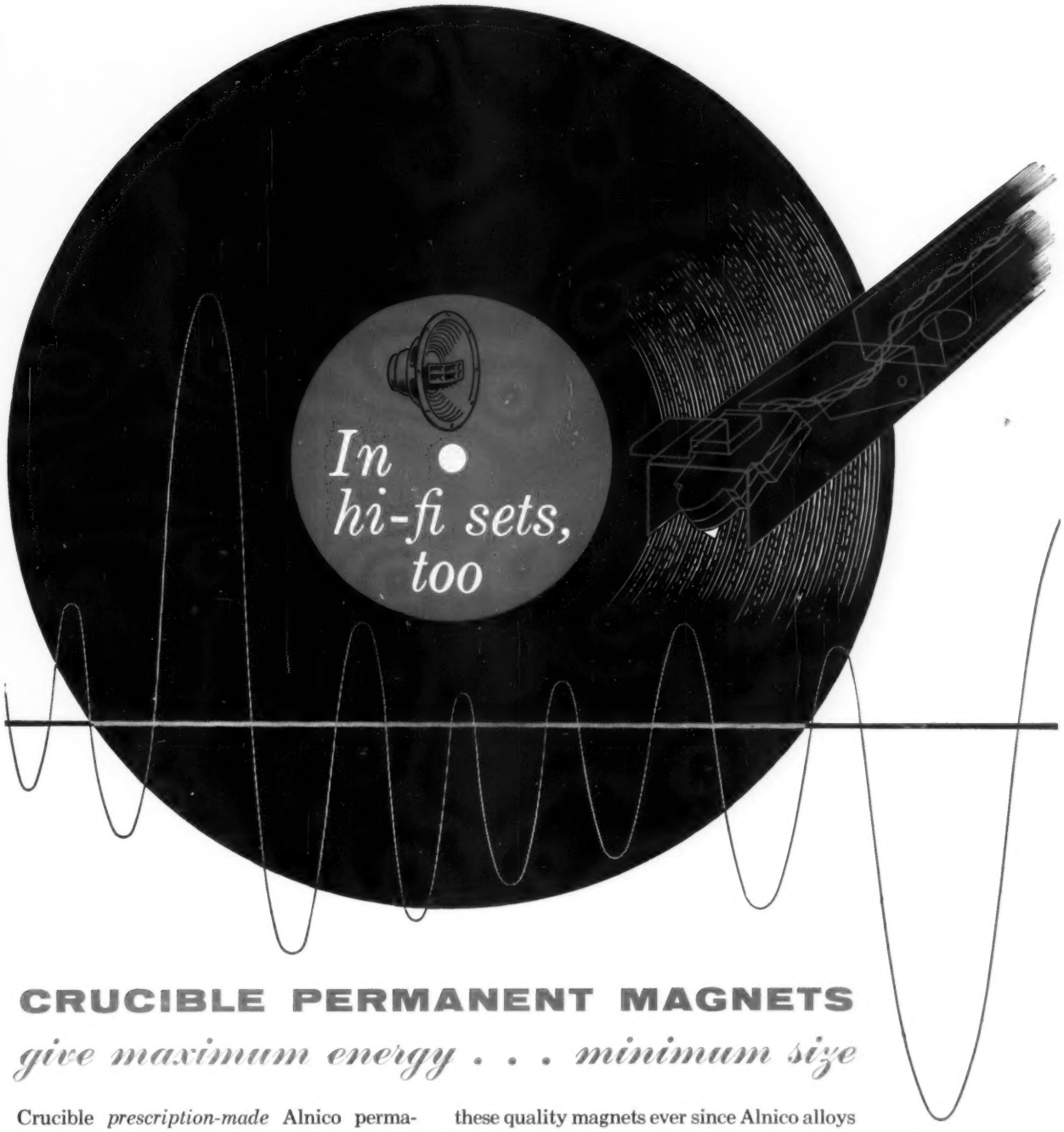

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